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Reckitt Benckiser (Australia) Pty Limited
44 Wharf Road
West Ryde
New South Wales 2114
AUSTRALIA

Patents ADP number *(if you know it)*: 07954431001 ✓

If the applicant is a corporate body, give the country/state of its incorporation: Australia

4. Title of the invention: Packaging means for emanating pyrethroid effective in controlling flying insects

5. Name of your agent *(if you have one)*: John Crawford McKnight

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*:
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Group Patents Department
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Signature(s) JMcKnight John Crawford McKnight Date 7 November 2003

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom

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Packaging means for emanating pyrethroid effective in controlling flying insects

Technical Field

The present invention relates generally to insect control and more particularly a packaging means for retaining and emanating vapour active pyrethroid that is effective in controlling flying insects, particularly mosquitoes.

Background Art

The control of flying insects in an indoor or an outdoor area has traditionally been achieved using articles or devices that dispense insecticide vapours into the atmosphere. Such articles or devices generally burn or heat a liquid or solid substrate to vaporise the active ingredient. For instance, in controlling mosquitoes, coils impregnated with an active ingredient are burnt so that heat from combustion causes the release of the active ingredient into the atmosphere, citronella oil candles are burnt so as to heat the citronella oil and allow it to evaporate into the atmosphere, while electric devices electrically heat the active ingredient so that it vaporises and is dispersed into the atmosphere. Battery operated, fan driven products are also used to control mosquitoes. The above mentioned products require an energy source in the form of combustion, heat or electricity. The release rates of active insecticides from continuous action products such as mosquito coils, candles, liquid vaporisers and electrically heated mats are essentially independent of the surrounding environment as the driving force for discharge of the active is supplied from within the system.

The abovementioned articles and devices used to control mosquitoes have disadvantages. The combustion of

mosquito coils requires a safe burning site and results in ash and smoke. The burning of a candle exposes a naked flame and therefore requires a safe burning site, while the use of electricity to heat an insecticidal device is costly in some developing countries and is not portable.

There also exists ambient temperature moth repellent products that rely on passive evaporation of the insecticide from a substrate into the environment. These products, which have commonly been used to control moths, do not require an external source of energy, such as combustion, heat or electricity to release the insecticide into the atmosphere. Instead, an insecticide that vapourises at ambient temperature is required for these products. The concept of an ambient temperature moth repellent has many benefits: they provide long lasting and continuous protection; they are efficient in that there is no need for a means of heating; they are portable, modern and practical.

The above known ambient temperature products, however, also have disadvantages. Firstly, many of the prior art products are only effective in small, enclosed spaces and require significant air movement for the insecticide to be effective in a larger area of space. Secondly, there is a short falling in the number of cost-effective products that are able to work efficiently using low doses of insecticide for the control of insects other than moths, such as mosquitoes.

In attempting to address the above short comings, the present inventors found an effective way for controlling insects, in particular mosquitoes, using a combination of substrate and a vapour active pyrethroid that allows passive emanation of the pyrethroid from the substrate at dose levels that achieve a minimum effective emanation

rate and are cost effective. These findings have been described previously in an application by the same applicants, the contents of which are attached as Appendix A. Such products involving a substrate and a vapour active pyrethroid as developed by the present inventors, or indeed any of the above discussed known ambient temperature products, typically take the form of a flat substrate or a concertina-type arrangement having a number of honeycomb-like cells. The concertina-type arrangements are able to be expanded through 180° to 360° and be opened on a table to provide a bridge or fan configuration or closed into a circle to give a hanging lantern configuration or be hung to give a linear lantern configuration. There are, however, a number of disadvantages associated with such arrangements: In for instance the flat substrate arrangements, due to their flat configuration, the available surface area from which active ingredient is able to be emanated is small. As such, low rates of emanation to the atmosphere are observed. In the case of the bridge or fan configuration, the honeycomb-like cells on the extreme ends of the fan are not fully expanded thereby leading to an inefficient use of available (or potential) surface area from which active ingredients are able to emanate. As such, lower rates of emanation to the atmosphere are observed. In the case of the hanging circular or linear configurations, these require some means of attachment, such as a hook, that will allow these to be hung to a wall or ceiling. Clearly, from a consumer point of view, having to attach a hook to a ceiling or a wall in order to allow the lantern to be hung is both time consuming and laborious and therefore undesirable. In addition, in configurations that are to be hung against the wall, reduced rates of emanation are observed due to the limited air flow around and through the substrate.

Whilst recognising the short comings of prior art articles for controlling mosquitoes and moths, the present inventors have sought to provide an improved packaging means for retaining and emanating vapour active pyrethroids that is able to achieve improved rates of emanation.

Disclosure of the Invention

The present inventors have found that imparting verticality (or height) to the substrate results in a higher rate of emanation of the pyrethroid and therefore more efficient insect control.

In a first aspect, the present invention is directed a packaging means for retaining vapour active pyrethroids comprising a holder and a cellulosic based substrate or matrix impregnated and/or dosed with the vapour active pyrethroid, wherein the holder comprises a top, a base and a longitudinal member vertically extending from between the top and base, and wherein the cellulosic matrix has a honeycomb configuration adapted to be retained between the top and base and has a surface area so as to achieve sufficient emanation of the vapour active pyrethroid to control flying insects.

In a second aspect, the invention provides a packaging means for retaining vapour active pyrethroids comprising a holder and a cellulosic based substrate or matrix impregnated and/or dosed with the vapour active pyrethroid, wherein the holder comprises a top, a base and a longitudinal member vertically extending from between the top and base, and wherein the cellulosic matrix has a honeycomb configuration adapted to be retained between the top and base and has a surface area so as to achieve sufficient emanation of the vapour active pyrethroid to control flying insects, and wherein the cellulosic

substrate or matrix is comprised of two or more discrete parts. It has been observed that according to the second aspect of the invention, increased emanation of vapour active pyrethroid is achieved through the use of two or more discrete cellulosic substrates or matrices. Although not wishing to be bound by theory, it is believed that the increased rate of emanation is achieved by the ability of the surrounding air/atmosphere to access the regions between the one or more discrete parts. In a particularly preferred embodiment, the cellulosic substrate or matrix is comprised of two discrete parts.

The longitudinal member extending from between the holder top and base is preferably able to be releasably attached to the top and base and may be in the form of a column or a spring. When in the form of a column, preferably the column is collapsible by folding at one or more hinged joints, however the column may be comprised of one or more parts which are collapsible by telescopic movement of the one or more parts of the column within the other parts of the column. Alternatively, the column may be comprised of two or more releasably interfitting parts that are able to be interfitted by means of a slotted configuration that are able to be detached from each other as well as the top and the base, and stored in the base. In yet a further alternative arrangement, the holder top is adapted to slide along the column thereby allowing the holder to be open and closed as required. When the longitudinal member extending from between the holder top and base is in the form of a spring, the spring may be compressed in the resting state so that the cellulosic based substrate or matrix is maintained in a collapsed state in the absence of an externally applied force. Alternatively, the spring may be uncompressed in the resting state so that the cellulosic based substrate or matrix is maintained in an extended state in the absence

of an externally applied force. Preferably also, the longitudinal member is capable of being stored within the packaging means when the top and base are in a closed position.

Desirably, the holder and the cellulosic based substrate or matrix are adapted to allow the cellulosic matrix to be releasably retained in the holder and replaced as required. This may be achieved by the provision of a slot within the periphery of each of the top and base and a card on each end of the cellulosic based substrate or matrix, wherein the cards are able to be slid into the slots thereby allowing the cellulosic based substrate or matrix to be releasably attached to the holder. This configuration has the advantage of allowing the cellulosic based substrate or matrix to be replaced without the need to detach the longitudinal member from the top or base while the top and base are in the closed or open state. It is also envisaged that the cellulosic based substrate or matrix may be adapted to receive the longitudinal member through an aperture thereby retaining the cellulosic based substrate or matrix between the top and base. In this configuration, the cellulosic based substrate or matrix is able to be replaced by detaching the top or base, or both, from the longitudinal member, mounting the cellulosic based substrate or matrix about the longitudinal member, and reattaching the top or base, or both, to the longitudinal member.

In a preferred embodiment of the invention, the cellulosic based substrate or matrix is attached to the top and base, wherein the base is able to be surface-mounted and is connected to the longitudinal member having a hook on its end, and wherein the cellulosic substrate or matrix is able to be extended and supported in the extended state by attachment of the top to the hook.

Preferably, the top is able to be attached to the hook by means of a ring located on the top.

In yet another particularly preferred embodiment of the invention, the packaging means further comprises an end-of-life (EOL) indicator. The indicator displays the number of times that the product has been in use through a dial indication (counter) that rotates one increment or 'use period' by means of a toothed gearing system each time a user opens the packaging means. This indicator also displays to the user when the product is nearing end-of-life.

In a third aspect, the invention provides a cellulosic based substrate or matrix having a honeycomb structure that when in an extended state, has an effective emanation surface area of about 50 - 5000 cm^2 and a height of about 8 - 23 cm. Preferably the height is about 17.5 cm.

In a fourth aspect, the invention provides a method of emanating a vapour active pyrethroid into the atmosphere by the use of a packaging means for retaining vapour active pyrethroids comprising a holder and a cellulosic based substrate or matrix impregnated and/or dosed with the vapour active pyrethroid,

wherein the holder comprises a top, a base and a longitudinal member vertically extending from between the top and base, and

wherein the cellulosic based substrate or matrix has a honeycomb configuration adapted to be retained between the top and base and has a surface area so as to achieve sufficient emanation of the vapour active pyrethroid to control flying insects.

In a fifth aspect, the invention is directed to the use of a packaging means for retaining and emanating vapour active pyrethroids comprising a holder and a

cellulosic based substrate or matrix impregnated and/or dosed with the vapour active pyrethroid,

wherein the holder comprises a top, a base and a longitudinal member vertically extending from between the top and base, and

wherein the cellulosic based substrate or matrix has a honeycomb configuration adapted to be retained between the top and base and has a surface area so as to achieve sufficient emanation of the vapour active pyrethroid to control flying insects.

It is desirable that the cellulosic based substrate or matrix is substantially sealed when the packaging means is in the closed state so that a minimal amount of vapour active pyrethroid is emanated into the atmosphere. This may be achieved with a protruding rim on the top and a means for engaging the protruding rim on the base to substantially seal the vapour active pyrethroid when the top and base are in the closed state. Most preferably, the top is a lid.

It will be appreciated that the packaging means in accordance with the present invention may be provided to a user with or without the cellulosic based substrate or matrix. In this way, the cellulosic based substrate or matrix, in accordance with the present invention, is envisaged as a refill product that is readily able to be attached or detached as desired and replaced for example, upon depletion of the impregnated and/or dosed vapour active pyrethroid. The means of attachment may be by the use of cards (glued, stapled or otherwise attached by any conventional means known to the skilled person), to the ends of the cellulosic substrate, wherein the holder and cards are adapted so that the cards are capable of being held between the holder top and base. Alternatively, the cellulosic based substrate or matrix may be directly fixed

to the top and base by means of, for example, clips, hook and loop fasteners (velcro®) or staples.

According to the various aspects of the invention, emanation of the vapour active pyrethroid from the cellulosic based substrate or matrix into the air controls flying insects. It will be understood that "control" of the flying insect population includes but is not limited to any one of or a combination of killing, repelling or knocking down a flying insect. It will be appreciated that a typical way of measuring the performance of an insecticide is in the form of "knockdown"

The phrase "surface area" is intended to mean the geometric surface area or the two dimensional surface area of the cellulosic based substrate or matrix. For instance, in a preferred embodiment where the cellulosic based substrate or matrix is paper, the surface area is the total area of both sides of the paper. Generally, the inventors have found that an increase in the surface area, particularly the effective emanation surface area, increases the emanation rate of the vapour active pyrethroid from the cellulosic based substrate or matrix into the atmosphere. It will be understood that the effective emanation surface area is the area of the cellulosic based substrate or matrix that allows emanation of the pyrethroid into the atmosphere. For instance, the inventors have found that increasing the number of folds in a paper substrate reduces the emanation rate of the pyrethroid from the paper substrate.

The term "height" of the cellulosic based substrate or matrix is intended to mean the height of the cellulosic matrix when extended in an open position; that is, the height of the cellulosic matrix extending between the holder top and base.

The cellulosic based substrate or matrix may be any substrate or matrix that contains cellulosic fibres and includes but is not limited to ground wood pulp, chemical wood pulp, straw preferably wheat straw, bagasse (residue from crushed sugarcane), esparto grass, bamboo, flax, hemp, jute and kenafrag fibres (cotton), cotton linters and recycled wastepaper in the form of, for instance, tissue, paper and cardboard. The cellulosic based substrate or matrix may be of varying grade and includes but is not limited to bleached, recycled and virgin cellulosic based substrates or matrices. It will be appreciated that different types of cellulosic based substrates or matrices will affect the emanation rate of the vapour active pyrethroid from the substrate or matrix into the atmosphere. Preferably, the cellulosic based substrate or matrix is paper, more preferably, bleached paper.

It will be understood that a "substrate" is something which underlies or serves as a basis or foundation and a "matrix" is something which gives origin or form to a thing or which serves to enclose it. Accordingly, it will be appreciated that the term "substrate" is more applicable to flat cellulose based articles while the term "matrix" is more applicable to three-dimensional cellulose based articles.

Preferably, the cellulosic based substrate or matrix has a grammage in the range of approximately 12 gsm to 260 gsm, more preferably in the range of approximately 18 gsm to 40 gsm. Most preferably, the cellulosic based substrate or matrix has a grammage of approximately 18 gsm.

The cellulosic based substrate or matrix is impregnated and/or dosed with a vapour active pyrethroid.

The substrate or matrix is deemed "impregnated" with the vapour active pyrethroid when the pyrethroid is either partially or completely distributed within the material of the substrate or matrix in such a manner that the pyrethroid fills all or some of the interstices of the material of the substrate or matrix and is directly held within the substrate or matrix and supported thereby. The substrate is deemed to be "dosed" with the vapour active pyrethroid when a specific quantity of the pyrethroid is applied to the substrate or matrix and absorbed either partially or completely into the pores of the substrate or matrix.

The cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of approximately 2.0-3000 mg/m^2. It will be appreciated that the amount of vapour active pyrethroid required per square metre will depend on the period of time the vapour active pyrethroid is required to emanate from the cellulose based substrate or matrix. For instance, for a cellulosic based substrate required to be effective in controlling insects, such as mosquitoes, over a 100 hour period, it is preferred that the cellulosic substrate or matrix be impregnated and/or dosed with vapour active pyrethroid in an amount of approximately 16 - 320 mg/m^2, more preferably 130 - 320 mg/m^2. Over a 300 hour period, it is preferred that the cellulosic substrate or matrix be impregnated and/or dosed with vapour active pyrethroid in an amount of approximately 48 - 960 mg/m^2, more preferably 390 - 960 mg/m^2. Over a 900 hour period, it is preferred that the cellulosic substrate or matrix be impregnated and/or dosed with vapour active pyrethroid in an amount of approximately 144 - 2880 mg/m^2, more preferably, 1170 - 2880 mg/m^2.

The emanation rate of the vapour active pyrethroid from the cellulosic based substrate into the atmosphere will be understood to mean the depletion of an amount of vapour active pyrethroid from the cellulosic based substrate or matrix over a certain period of time. The inventors have found that the emanation rate is affected by the surface area of the cellulose based substrate or matrix, the duration of emanation being determined by the amount of the vapour active pyrethroid applied to the substrate or matrix.

It will be appreciated that one or more vapour active pyrethroids may be employed in the present invention. It will be understood that vapour active pyrethroids are those that are volatile at ambient temperature without heat or combustion. The volatile pyrethroids are preferably selected from the group consisting of metofluthrin transfluthrin, empenthrin, methothrin, tefluthrin and fenfluthrin. Preferably, the vapour active pyrethroid is metofluthrin. Metofluthrin has high potency against mosquitoes, flies, and moths. The chemical name of metofluthrin is 2,3,5,6-tetrafluro-4-(methoxymethyl)benzyl(EZ)-(1RS,3RS;1RS,3SR)-2,2-dimethyl-3-(prop-1-enyl)cyclopropanecarboxylate. Metofluthrin is available from Sumitomo Chemical Company.

Insects within the context of the invention include, but are not limited to, biting Dipterous pests (Order Diptera) such as mosquitoes (Family Culicidae), biting midges (Family Ceratopogonidae), black flies (F. Simulidae), sandflies (certain Psychodidae) and biting flies (various families e.g. some Muscidae and Tabanidae), but may also include non-biting Dipterous insects (e.g. flies and midges of various families including Muscidae, Calliphoridae, Drosophilidae, Chironomidae and

Psychodidae), as well as certain moths (Order Lepidoptera).

In the context of the present invention, the inventors have found that paper thickness and type will affect the emanation rate. Further, they have found that increasing the level of vapour active pyrethroid will increase the duration of emanation. Also increasing the surface area, increasing the temperature and increasing the air flow will increase the emanation rate, while folding the paper will decrease the emanation rate.

The holder and the cellulosic based substrate or matrix containing the pyrethroid may be folded between an open form and a closed form such that they are expandable or are re-closable structures. This means that when insect control is not required, the holder and/or the cellulosic based substrate or matrix may be closed and stored in a form which minimises the surface area containing the vapour active pyrethroid that is exposed to the atmosphere. Conversely, when insect control is required, the holder and/or the cellulosic based substrate or matrix may be expanded into an open form thereby increasing the surface area of cellulosic based substrate or matrix containing the pyrethroid that is exposed to the atmosphere allowing the pyrethroid to emanate into the atmosphere. It is also envisaged that the amount of vapour active pyrethroid emanated into the atmosphere may be controlled by maintaining the top and base in an intermediate state between the open and closed states so that the cellulosic based substrate or matrix is in a partially expanded form.

It will be appreciated that the cellulosic based substrate or matrix is a three dimensional structure having a plurality of cells such as honeycomb like

arrangements. It will also be appreciated that the cellulosic based substrate or matrix has two ends. Preferably, the two ends of the cellulosic based substrate or matrix are in contact with material through which the vapour active pyrethroid cannot migrate and/or be absorbed. Preferably, the two ends of the cellulosic based substrate or matrix are attached to a card (for example, cardboard lined with polymer film or with aluminium foil), such that the cellulosic based substrate or matrix impregnated and/or dosed with the active pyrethroid is in contact with the polymer film or foil side of the cardboard.

The present invention will now be described in detail with reference to a number of preferred embodiments as illustrated in the accompanying drawings.

Brief Description of the Drawings

Figure 1 depicts a packaging means according to an embodiment of the invention wherein the top and base are in the open state within which the cellulosic based substrate or matrix is retained.

Figure 2a depicts an exploded view of the packaging means when in a closed state according to another embodiment of the invention wherein the longitudinal member is in the form of a column that is collapsable by disassembly about a slotted configuration. Shown is the holder top, the cellulosic cartridge, and the holder base within which the disassembled longitudinal member is stored.

Figure 2b depicts the packaging means according Figure 2a in the open state within which the cellulosic based substrate or matrix is retained.

Figure 2c depicts the packaging means according to Figure 2a in the open state without the cellulosic based substrate or matrix.

Figure 3a depicts an exploded view of the packaging means when in a closed state according to further embodiment of the invention wherein the longitudinal member is in the form of a spring. Shown is the holder top, the cellulosic cartridge, and the holder base within which the spring is stored in a compressed state.

Figure 3b depicts the packaging means according to Figure 3a in an open state within which the cellulosic based substrate or matrix is retained.

Figure 3c depicts the packaging means according to Figure 3a in an open state without the cellulosic based substrate or matrix.

Figure 4a depicts a packaging means when in a closed state according to another embodiment of the invention wherein the longitudinal member is in the form of a column about which the tower is able to be moved along in a sliding motion wherein the column further comprises an indicator.

Figure 4b depicts the packaging means according to Figure 4a showing a cutaway view of the column and indicator mechanism.

Figure 4c depicts an exploded view of the packaging means according to Figure 4a.

Figure 4d depicts the packaging means according to Figure 4a in the open state within which the cellulosic based substrate or matrix is retained.

Figure 4e depicts the packaging means according to Figure 4a in the open state without the cellulosic based substrate or matrix.

Figure 4f depicts the packaging means according to Figure 4a in the closed state with the cellulosic based substrate or matrix, also in the closed state, ready for insertion into the holder between the top and base.

Figure 5a depicts a perspective view of the packaging means according to another embodiment of the invention wherein the base is surface-mounted and the cellulosic matrix is attached to the base and top and is able to be retained in the extended state by means of a hook located on one end of the longitudinal member to which the top is able to be attached.

Figure 5b depicts a rear view of the packaging means according to Figure 5a.

Figure 5c depicts a side view of the packaging means according to Figure 5a.

Figure 6a depicts a perspective view of a packaging means in an open state according to another embodiment of the present invention wherein the cellulosic based substrate or matrix is comprised of two discrete parts.

Figure 6b depicts the packaging means of Figure 6a in a closed state.

Figure 6c depicts a perspective view of the cellulosic based substrate or matrix comprised of two discrete parts.

Figure 6d depicts a front view of the cellulosic based substrate or matrix according to Figure 6c.

Figure 6e depicts a side view of the cellulosic based substrate or matrix according to Figure 6c.

Figure 7 depicts a perspective view of a packaging means in a closed state according to another embodiment of the present invention in which the column is comprised of two interfitting parts.

Detailed description of the Invention

Referring to Figure 1, a packaging means according to a preferred embodiment of the invention is shown comprising a top (1), a base (3) and a cellulosic based substrate or matrix (5) retained between the top (1) and the base (3). The cellulosic based substrate or matrix (5) is a three dimensional structure with a plurality of cells (6) such as honeycomb like shapes and a concertina type configuration having two ends which are attached to the top (1) and base (3). The cellulosic based substrate or matrix (5) may be any substrate or matrix that contains cellulose and includes but is not limited to tissue, paper, cardboard and rice paper. The cellulosic based substrate or matrix (5) may be of varying quality and includes but is not limited to bleached, recycled and virgin cellulosic based substrates or matrices. It will be appreciated that different types of cellulosic based substrates or matrices will affect the emanation rate of the vapour active pyrethroid from the substrate or matrix into the atmosphere. Preferably, the cellulosic based substrate or matrix (5) is paper, more preferably, bleached paper.

Figure 2a is directed to a packaging means according to another embodiment of the invention, this time showing

detail of the longitudinal member (11) which is disassembled and stored in the base (3). Figure 2(b) shows the packaging means in an open state wherein the cellulosic based substrate or matrix (5) is retained between the top (1) and base (3). The longitudinal member (11), in this case a column that is able to be disassembled by virtue of a slotted configuration (12), is clearly shown in Figure 2(c) in the absence of the cellulosic based substrate or matrix.

A further embodiment according to the present invention is depicted in Figures 3(a) – 3(c) wherein the longitudinal member (11) is a spring. In this embodiment, the spring is expanded in the resting state and as such, the top (1) has a latch (4) which clips onto a groove (8) in the base (3) thereby allowing the top and base to be maintained in the closed state.

A further embodiment according to the present invention is depicted in Figures 4(a) - 4(f) wherein the longitudinal member (11) is a column that is not collapsable. The top of the column comprises an indicator (20) the mechanism of which is shown in an exploded and cutaway view in Figure 4(b). In this embodiment, the top (1), by virtue of an aperture (10) (the aperture (10) is clearly depicted in Figure 4(c)), is moved towards the base (3) by sliding motion along the column (11) in order to close the holder and the attached cellulosic based substrate or matrix (5). The cellulosic based substrate or matrix (5) may be attached to the top (1) and base (3) by any conventional means known to persons skilled in the art, however, one preferred method is the use of a cards (7, 9) attached to both ends of the cellulosic matrix which may be clipped or otherwise held in position, such as by means of glue or staples. A particularly preferred method of attaching the cellulosic based substrate or

matrix (5) is depicted in Figures 4(e) and 4(f) in which the top (1) and base (3) comprise slots (13) along the periphery that allows the sliding in of cards (7, 9) to thereby retain the cellulosic based substrate or matrix (5) into position. Advantageously, and as is shown in Figure 4(f), this arrangement allows the cellulosic based substrate or matrix (5) to be replaced while it, and the holder, is in the closed position.

Referring now specifically to Figure 4(b), in this particularly preferred embodiment, the EOL indicator (20) is actuated by the opening and closing of the holder. The user of the product sets a counter located at the top of the column to the life period of the product depending on the dosage of the cellulosic based substrate or matrix with vapour active pyrethroid, for example 100 hours, by counterclockwise rotation of the counter. The counter then rotates in the clockwise direction towards zero with each opening and closing of the holder. Progress towards end-of-life is indicated, preferably by graphical means, through a window (24) located at the top of the column (11). The graphic area, visible through the window (24), is printed on a disc (21) that rotates slowly with each opening and closing of the holder. In this way, indication of EOL is able to be represented by, for example, a series of dots of changing (increasing or decreasing) size, numerical means, a change or gradation in colour or combinations of any of such representations. The upper and lower faces of the disc (21) have a mirror image saw-toothed gear profile (22) and the disc (21) is retained in a cylindrical enclosure located at the top of the column (11) with a spindle (26) providing lateral location through a hole located on a disc (25) that defines the enclosure floor, and a hole in a cap (23) that covers the cylindrical enclosure. Both the enclosure floor (disc (25)) and the underside of the cap (23) also

have saw-toothed gear profiles (22a, 22b). The gears on the disc (21) can exist in one of three states: (i) engaged with the gear teeth (22b) located on disc (25), (ii) engaged with the gear teeth (22a) located on the underside of the cap (23), or (iii) in a neutral position between the gear teeth (22a, 22b) of cap (23) and disc (25) wherein this position allows the user to reset the EOL mechanism.

During operation, the holder is preferably opened at night to allow emanation of the vapour active pyrethroid when insect control is desired and closed in the morning so as to prevent emanation of the vapour active pyrethroid when insect control is not desired. As the holder is opened, a tongue (28) located on the top (1) strikes the underside of the spindle (26), driving the spindle upwards into the gear teeth (22a) on the underside of the cap (23). These gear teeth (22a) partially rotate the disc (21) in a clockwise direction as the disc gear teeth (22) and cap gear teeth (22b) engage. When the holder is next closed, the gear teeth (22) then lower back onto the gear teeth (22b) located on disc (25), again partially rotating the disc (21) clockwise. Therefore continuous opening and closing of the top translates into rotary motion of the disc (21) and in turn the rotary motion of the graphic display viewed through the window (24).

A further embodiment according to the present invention is depicted in Figures 5(a) to 5(c). In this embodiment, the packaging means comprises a cellulosic based substrate or matrix (5) that is able to be extended in the vertical direction from a base (3) to a top (1). The base (3) is able to be mounted on a surface, such as a table or ledge, and is attached at one end to the cellulosic based substrate or matrix (5) with the other end of the cellulosic substrate or matrix (5) being

attached to the top (1). The top (1) is able to connected to the base (3) and the attached cellulosic based substrate or matrix supported in an open position by means of a vertically extending longitudinal member in the form of a thin rod (11) with a hook (30) at one end. When a user desires emanation of vapour active pyrethroid into the atmosphere, the user extends the cellulosic based substrate or matrix to an open position and maintains it in the open position by hooking a ring (32) located on the top (1) on the hook (30). Conversely, when the user desires no emanation of the vapour active pyrethroid, the user allows the cellulosic based substrate or matrix (5) to retract towards the base (3) by unhooking the top (1) from the hook (30).

Another aspect of the invention is depicted in Figures 6(a) to 6(e) in which according to a preferred embodiment of this aspect, the packaging means comprises a cellulosic based substrate or matrix that is comprised of two discrete parts having substantially identical dimensions of height and width. The inventors have surprisingly found that in this configuration, an increased rate of emanation is observed. The discrete cellulosic based substrate or matrix parts may be positioned within the holder in any orientation, however, in a preferred embodiment, the parts are orientated such that the column (11) and the space (12) between the discrete parts (5a, 5b) are aligned as shown in Figure 6(a)

Referring to Figures 6(a) and 6(b), a packaging means according to the second aspect of the invention is depicted having a top (1) and a base (3) to which a two-part cellulosic based substrate or matrix (5a, 5b) is attached by means of cards (7, 9) that are able to retained with the top (1) and base (3) by sliding motion

in slots (13). The packaging means further comprises an indicator (20) which has been described in detail with reference to Figures 4(a) to 4(f). The two-part cellulosic based substrate or matrix is also clearly depicted in Figures 6(c) to 6(e) attached to cards (7, 9).

Another preferred embodiment of the invention is depicted in Figure 7 in which the column (11) is provided to the consumer in two parts (11a, 11b) which once interfitted, are unable to be disassembled. It will be appreciated however that the present invention also provides an alternative embodiment in which the column (11) with parts (11a, 11b) is able to be releasably interfitted such that a consumer is able to assemble or disassemble the column parts (11a and 11b) as desired. In this configuration, the parts (11a, 11b) are, for example, male and female portions that are able to be releasably interfitted.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

APPENDIX A

Technical Field

The present invention relates generally to flying insect control and more particularly to a cellulosic based substrate or matrix containing a vapour active pyrethroid that is effective in controlling flying insects, particularly mosquitoes.

Background Art

The control of flying insects in an indoor or an outdoor area has traditionally been achieved using articles or devices that dispense insecticide vapours into the atmosphere. Such articles or devices generally burn or heat a liquid or solid substrate to vaporise the active ingredient. For instance, in controlling mosquitoes, coils impregnated with an active ingredient are burnt so that heat from combustion causes the release of the active ingredient into the atmosphere, citronella oil candles are burnt so as to heat the citronella oil and allow it to evaporate into the atmosphere, while electric devices electrically heat the active ingredient so that it vaporises and is dispersed into the atmosphere. Battery operated, fan driven products are also used to control mosquitoes. The above mentioned products require an energy source in the form of combustion, heat or electricity. The release rates of active insecticides from continuous action products such as mosquito coils, candles, liquid vaporisers and electrically heated mats are essentially independent of the surrounding environment, the driving force for discharge of the active being supplied from within the system.

The abovementioned articles and devices used to control mosquitoes have disadvantages. The combustion of mosquito coils requires a safe burning site and results in

ash and smoke. The burning of a candle exposes a naked flame and therefore also requires a safe burning site. The use of electricity to heat an insecticidal device is costly in some developing countries and is not portable.

There also exists ambient temperature moth repellent products that rely on passive evaporation of the insecticide from a substrate into the environment. These products, which have commonly been used to control moths, do not require an external source of energy, such as combustion, heat or electricity to release the insecticide into the atmosphere. Instead, an insecticide that vapourises at ambient temperature is required for these products. The concept of an ambient temperature moth repellent has many benefits: they provide long lasting and continuous protection; they are efficient in that there is no need for a means of heating; and they are portable, modern and practical.

The above known ambient temperature products, however, also have disadvantages. Firstly, many of the prior art products are only effective in small, enclosed spaces and/or require significant air movement for the insecticide to be effective in a larger area of space. Secondly, the inventors are not aware of any cost-effective ambient emanation products that are able to work efficiently using low doses of insecticide for the control of insects other than moths, such as mosquitoes.

There is clearly a need for insecticidal products, particularly cost effective products, that do not require an external input of energy for them to be effective in controlling flying insects, particularly mosquitoes.

Whilst recognising the short comings of prior art articles for controlling mosquitoes and moths, the present

inventors have sought to provide an improved vapour active insecticide product with high insecticidal potency in the continuous control of flying insects without the need for electricity, heat or combustion.

Disclosure of the Invention

The present inventors have found an effective way of controlling flying insects, in particular mosquitoes, using a combination of substrate, vapour active pyrethroid and carrier solvent that allows emanation of the pyrethroid from the substrate at dose levels that achieve an effective emanation rate and are cost effective.

In a first aspect, the present invention is directed to a cellulosic based substrate or matrix for controlling flying insects, the cellulosic based substrate or matrix impregnated and/or dosed with a vapour active pyrethroid in a carrier solvent, wherein the cellulosic based substrate or matrix has a surface area in the range of 50-5000 cm^2 and the vapour active pyrethroid is present in an amount of approximately 2.0-3000 mg/m^2 such that the vapour active pyrethroid is emanated into an environment with non-augmented air movement at a rate of at least approximately 0.040 mg/h at a temperature in the range of approximately 18-40°C.

In a second aspect, the present invention is directed to a cellulosic based substrate or matrix for controlling flying insects, the cellulosic based substrate or matrix impregnated and/or dosed with an insecticidally effective amount of a vapour active pyrethroid in a carrier solvent, wherein the carrier solvent has an evaporation rate according to ASTM D3539-87 of less than approximately 1.0, a boiling point in the range of approximately 150-265°C and a polarity index in the range of approximately 0.0-4.0, such that the vapour active pyrethroid is emanated

into the environment at a rate of at least approximately 0.040 mg/h.

In a third aspect, the present invention is directed to a flying insect control article comprising:

a) a cellulosic based substrate or matrix with a surface area in the range of 50-5000 cm^2 impregnated and/or dosed with a solution of vapour active pyrethroid in an amount of approximately 2.0-3000 mg/m^2 in a carrier solvent, the cellulosic based substrate or matrix impregnated and/or dosed with the vapour active pyrethroid in an amount such that the vapour active pyrethroid is emanated into an environment with non-augmented air movement at a rate of at least approximately 0.040 mg/h at a temperature in the range of approximately 18-40°C; and

b) a protective material that is attached to the cellulosic based substrate or matrix into which protective material the vapour active pyrethroid does not migrate and/or is not absorbed;

wherein the cellulosic based substrate and/or matrix exists in a closed and open form such that when in the open form the vapour active pyrethroid is able to emanate from the substrate into the environment to control flying insects and when in the closed form the protective material covers the substrate or matrix to minimise emanation of the vapour active pyrethroid into the environment.

In a fourth aspect, the present invention is directed to a flying insect control article comprising:

a) a cellulosic based substrate or matrix for controlling flying insects, the cellulosic based substrate or matrix impregnated and/or dosed with an insecticidally effective amount of a vapour active pyrethroid in a

carrier solvent, wherein the carrier solvent has an evaporation rate according to ASTM D3539-87 of less than approximately 1.0, a boiling point in the range of approximately 150-265°C and a polarity index in the range of approximately 0.0-4.0 such that the vapour active pyrethroid is emanated into the environment at a rate of at least approximately 0.040 mg/h; and

b) a protective material that is attached to the cellulosic based substrate or matrix into which protective material the vapour active pyrethroid does not migrate and/or is not absorbed;

wherein the cellulosic based substrate and/or matrix exists in a closed and open form such that when in the open form the vapour active pyrethroid is able to emanate from the substrate into the atmosphere and when in the closed form the protective material covers the substrate or matrix to minimise emanation of the vapour active pyrethroid into the atmosphere.

In a fifth aspect, the present invention is directed to a packaged flying insect control article comprising:

a) a cellulosic based substrate or matrix with a surface area in the range of 50-5000 cm^2 impregnated and/or dosed with a solution of vapour active pyrethroid in an amount of approximately 2.0-3000 mg/m^2 in a carrier solvent, the cellulosic based substrate or matrix impregnated and/or dosed with the vapour active pyrethroid in an amount such that the vapour active pyrethroid is emanated into an environment with non-augmented air movement at a rate of at least approximately 0.040 mg/h at a temperature in the range of approximately 18-40°C; and

b) a packaging material enclosing the cellulosic based substrate or matrix into which material the vapour active pyrethroid does not migrate and/or is not absorbed;

wherein when the packaging material enclosing the cellulosic based substrate or matrix is removed from around the cellulosic based substrate or matrix, the vapour active pyrethroid is free to emanate from the cellulosic based substrate or matrix that is exposed to the environment to control flying insects.

In a sixth aspect, the present invention is directed to a packaged flying insect control article comprising:

a) a cellulosic based substrate or matrix impregnated and/or dosed with an insecticidally effective amount of a vapour active pyrethroid in a carrier solvent, wherein the carrier solvent has an evaporation rate according to ASTM D3539-87 of less than approximately 1.0, a boiling point in the range of approximately 150-265°C and a polarity index in the range of approximately 0.0-4.0 such that the vapour active pyrethroid is emanated into the environment at a rate of at least approximately 0.040 mg/h; and

b) a packaging material enclosing the cellulosic based substrate or matrix into which material the vapour active pyrethroid does not migrate and/or is not absorbed;

wherein when the packaging material enclosing the cellulosic based substrate or matrix is removed from around the cellulosic based substrate or matrix, the vapour active pyrethroid is free to emanate from the cellulosic based substrate or matrix that is exposed to the environment to control flying insects.

In a seventh aspect, the present invention is directed to a stable flying insect control article comprising:

a cellulosic based substrate or matrix with a surface area in the range of 50-5000 cm^2, wet with a solution of vapour active pyrethroid in an amount of approximately 2.0-3000 mg/m^2 and a carrier solvent, enclosed by a packaging material;

wherein the vapour active pyrethroid emanates from the cellulosic substrate or matrix into an environment with non-augmented air movement at a rate of at least approximately 0.040 mg/h at a temperature in the range of approximately 18-40°C but does not migrate and/or is not absorbed into the packaging material.

In an eighth aspect, the present invention is directed to a stable flying insect control article comprising:

a cellulosic based substrate or matrix wet with a solution of an insecticidally effective amount of a vapour active pyrethroid and a carrier solvent having an evaporation rate according to ASTM D3539-87 of less than approximately 1.0, a boiling point in the range of approximately 150-265°C and a polarity index in the range of approximately 0.0-4.0, enclosed by a packaging material;

wherein the vapour active pyrethroid emanates from the cellulosic substrate or matrix into the environment at a rate of at least approximately 0.040 mg/h but does not migrate and/or is not absorbed into the packaging material

In a ninth aspect, the present invention is directed to a method for controlling flying insects comprising the steps of:

a) providing the cellulosic based substrate or matrix or insect control article according to the first to eighth aspects of the invention;

b) exposing the cellulosic based substrate or matrix to an environment with non-augmented air movement; and

c) allowing the vapour active pyrethroid impregnated within and/or dosed on the cellulosic based substrate or matrix to passively evaporate into the environment.

In a tenth aspect, the present invention is directed to a method of packaging a cellulosic based substrate or

matrix or insect control article according to the first to eighth aspects of the invention comprising the steps of:

a) providing a packaging material through which the vapour active pyrethroid does not migrate and/or is not absorbed;

b) forming a pouch with the packaging material;

c) filling the pouch with the cellulosic based substrate or matrix or insect control article; and

d) sealing the pouch.

The cellulosic based substrate or matrix may be any substrate or matrix that contains cellulosic fibres and includes but is not limited to ground wood pulp, chemical wood pulp, straw preferably wheat straw, bagasse (residue from crushed sugarcane), esparto grass, bamboo, flax, hemp, jute and kenafrag fibres (cotton), cotton linters and recycled wastepaper in the form of, for instance, tissue, paper and cardboard. The cellulosic based substrate or matrix may be of varying grade and includes but is not limited to bleached, recycled and virgin cellulosic based substrates or matrices. It will be appreciated that different types of cellulosic based substrates or matrices will affect the emanation rate of the vapour active pyrethroid from the substrate or matrix into the atmosphere. Preferably, the cellulosic based substrate or matrix is paper, more preferably, bleached paper.

It will be understood that a "substrate" is something which underlies or serves as a basis or foundation and a "matrix" is something which gives origin or form to a thing or which serves to enclose it. Accordingly, it will be appreciated that the term "substrate" is more applicable to flat cellulose based articles while the term

"matrix" is more applicable to three-dimensional cellulose based articles.

Preferably, the cellulosic based substrate or matrix according to the invention has a grammage in the range of approximately 12 gsm to less than 260 gsm, more preferably in the range of approximately 12 gsm to 150 gsm, even more preferably in the range of approximately 12 gsm to 40 gsm. Most preferably, the cellulosic based substrate or matrix has a grammage of approximately 18 gsm.

According to the present invention, the cellulosic based substrate or matrix is impregnated and/or dosed with a vapour active pyrethroid. The substrate or matrix is deemed "impregnated" with the vapour active pyrethroid when the pyrethroid is either partially or completely distributed within the material of the substrate or matrix in such a manner that the pyrethroid fills all or some of the interstices of the material of the substrate or matrix and is directly held within the substrate or matrix and supported thereby. The substrate is deemed to be "dosed" with the vapour active pyrethroid when a specific quantity of the pyrethroid is applied to the substrate or matrix and absorbed either partially or completely into the pores of the substrate or matrix.

The cellulosic based substrate or matrix according to the invention is impregnated and/or dosed with a vapour active pyrethroid, in an amount that is insecticidally effective, preferably in an amount of about 2.0-3000 mg/m^2, more preferably, about 2.0-1000 mg/m^2. It will be appreciated that the amount of vapour active pyrethroid required per square meter will depend on the period of time the vapour active pyrethroid is required to emanate from the cellulose based substrate or matrix. For instance, for a cellulosic based substrate required to be

effective in controlling insects, such as mosquitoes, over a 100 hour period, it is preferred that the cellulosic substrate or matrix be impregnated and/or dosed with vapour active pyrethroid in an amount of approximately 16-320 mg/m^2, more preferably about 130-320 mg/m^2. Over a 300 hour period, it is preferred that the cellulosic substrate or matrix be impregnated and/or dosed with vapour active pyrethroid in an amount of approximately 48-960 mg/m^2, more preferably about 390-960 mg/m^2. Over a 900 hour period, it is preferred that the cellulosic substrate or matrix be impregnated and/or dosed with vapour active pyrethroid in an amount of approximately 144-2880 mg/m^2, more preferably, about 1170-2880 mg/m^2.

Preferably, the cellulosic based substrate or matrix according to the various aspects of the invention has a surface area of about 50-5000 cm^2, more preferably, 180-2400 cm^2.

In a preferred embodiment, a surface area of cellulosic based substrate or matrix in the range of approximately 1250-2400 cm^2 is impregnated with approximately 20-40 mg of vapour active pyrethroid to achieve 100 hours of use, or approximately 60-120 mg of vapour active pyrethroid to achieve 300 hours of use, or approximately 180-360 mg of vapour active pyrethroid to achieve 900 hours of use.

The phrase "surface area" is intended to mean the total geometric or two dimensional surface area of the cellulosic based substrate or matrix that is exposed to the atmosphere or environment into which the vapour active pyrethroid is to emanate. It will be understood that where the cellulosic based substrate or matrix is a flat piece of paper, the surface area is the sum of the area of both sides of the paper. It will further be understood

that the surface area of any other configuration will be the sum of the area of the surfaces exposed to the atmosphere/environment. Generally, the inventors have found that an increase in the surface area increases the emanation rate of the vapour active pyrethroid from the cellulosic based substrate or matrix into the atmosphere.

It will be understood that vapour active pyrethroids are those that are volatile at ambient temperature without heat or combustion. The vapour active pyrethroids are preferably selected from the group consisting of metofluthrin ($1.4x10^{-5}$mmHg/ 25°C), transfluthrin ($2.6x10^{-5}$mmHg/25°C, $4.0x10^{-1}$mPa/20°C), empenthrin (14mPa/23.6°C), methothrin, tefluthrin (8.4mPa/20°C, 50mPa/40°C), and fenfluthrin (1mPa/20°C). It will be appreciated that one or more vapour active pyrethroids may be employed in the present invention. Preferably, the vapour active pyrethroid is metofluthrin. Metofluthrin has high potency against mosquitoes, flies, and moths. The chemical name of metofluthrin is 2,3,5,6-tetrafluro-4-(methoxymethyl)benzyl-(EZ)-(1RS,3RS;1RS,3SR)-2,2-dimethyl-3-(prop-1-enyl)cyclopropanecarboxylate. Metofluthrin is available from Sumitomo Chemical Company.

The emanation or release of the vapour active pyrethroid from the cellulosic based substrate or matrix into the atmosphere/environment may be referred to as the emanation rate or release rate and will be understood to mean the depletion of an amount of vapour active pyrethroid from the cellulosic based substrate or matrix over a certain period of time and has a unit of measurement of mg/hour. The emanation rate is a measure of efficacy in controlling flying insects. The inventors have found that the emanation rate is affected by the surface area of the cellulose based substrate or matrix

and the amount of the vapour active pyrethroid impregnated and/or dosed onto the substrate or matrix.

The present inventors have found that emanation of a vapour active pyrethroid, preferably metofluthrin, from a cellulosic based substrate or matrix into the atmosphere at a rate of at least approximately 0.040 mg/h, more preferably at least approximately 0.075 mg/h, is required to effectively control flying insects, particularly mosquitoes and moths. The present inventors believe that a lower emanation rate of at least approximately 0.040 mg/h may be more effective in controlling flying insects such as moths, while a higher emanation rate of at least approximately 0.075 mg/h may be more effective in controlling insects such as mosquitoes. Throughout the specification, the emanation rate of approximately 0.040 mg/h may be referred to as the minimum effective emanation rate (MEER). This MEER may be achieved by controlling a variety of parameters including but not limited to the quantity of vapour active insecticide impregnated and/or dosed onto the cellulosic based substrate or matrix; the size, mass and folding of the cellulosic based substrate or matrix; temperature; and air flow.

By virtue of extrapolation, the present inventors expect the emanation rate of vapour active pyrethroid from the cellulosic substrate or matrix of at least approximately 0.040 mg/h, preferably 0.075 mg/h, to be effective in controlling flying insects, particularly mosquitoes, at a temperature in the range of approximately 18-40°C. The possibility of achieving emanation of the vapour active pyrethroid from the cellulosic substrate or matrix according to the present invention at low temperatures in the range of approximately 18-21°C contributes to the commercially viability of the various aspects of the invention.

Preferably, the vapour active pyrethroid is emanated from the cellulosic matrix or substrate at a rate of at least approximately 0.04 mg/h, preferably at least approximately 0.075 mg/h, at a temperature in the range of about 18-40°C, more preferably about 21-35°C.

It will be understood that an environment with non-augmented air movement refers to natural air movement that passes over and/or through the cellulosic based substrate or matrix, thereby allowing the vapour active insecticide to passively emanate into the atmosphere. It excludes the use of fans, heat and other mechanical means of increasing air movement. Suitable environments include but are not limited to enclosed rooms and open volumes of space, such as patios and the like, with air movement provided by natural air movement.

The cellulosic based substrate/matrix and the insect control devices of the present invention are used to control flying insects. The flying insects may be selected from but not limited to biting Dipterous pests (Order *Diptera*) such as mosquitoes (Family *Culicidea*), biting midges (Family *Ceratopogonidae*), black flies (F. *Simulidae*), sandflies (certain *Psychodidae*) and biting flies (various families eg *Muscidae* and *Tabanidae*) and non-biting Dipterous insects (e.g. flies and midges of various families including, but not limited to *Muscidae*, *Calliphoridae*, *Drosophilidae*, *Chironomidae* and *Psychodidae*) and certain moths (Order *Lepidoptera*). Preferably, the cellulosic based substrate/matrix and the insect control devices of the present invention are used to control mosquitoes.

It will be understood that "control" of the flying insect population includes but is not limited to any one of or a combination of killing, repelling or knocking down

a flying insect. It will be appreciated that a typical way of measuring the performance of an insecticide is in the form of "knockdown".

Throughout the specification, the term "passive emanation" is used to describe the process by which the vapour active pyrethroid emanates from the cellulosic based substrate or matrix into the atmosphere without the application of external energy.

According to the invention, the cellulosic based substrate or matrix is impregnated and/or dosed with the vapour active pyrethroid, preferably metofluthrin, in a carrier solvent. The carrier solvent may be any solvent or combination of solvents in which the vapour active pyrethroid is soluble.

The inventors have identified three important physical properties of solvents that may be used to characterise and classify preferred carrier solvents. The first is the boiling point, the second is the evaporation rate according to the ASTM D3539-87 and the third is the polarity of the solvent as determined by the Snyder polarity index. (L.R.Snyder, J Chromatographic Science, 1978, 16, 223).

Preferably, the carrier solvent has a boiling point in the range between about 33-330°C, more preferably, about 50-265°C.

The carrier solvent may be selected from, but not limited to, chlorinated hydrocarbons (e.g. 1,1,1-trichloroethane, dichloromethane, chloroform); alcohols (e.g. methanol, ethanol, n-propanol); ketones (e.g. acetone); alcohol and ketone mixtures (e.g. acetone/ethanol (1:1 by volume)); normal paraffins with a

boiling point range of about 155-276°C (e.g. Norpar 12); dearomatised aliphatic hydrocarbons and their blends in the boiling point range of about 33-265°C (e.g. pentane, heptane, hexane, Exxsol D40, Exxsol D80 and Exxsol D100); isoparaffins in the boiling point range of about 150-300°C (e.g. Isopar G, and Isopar M); glycol ethers in the boiling point range of about 120-243°C; natural or synthetically derived aroma chemicals, preferably in the boiling point range of approximately 120-250°C (e.g. monoterpenes and sesquiterpenes, including monoterpene and sesquiterpene alcohols, aldehydes, ketones, esters, oxides and hydrocarbons such as linalool, geraniol, citronellal, citral, geranial, menthone, linalyl acetate, bornyl acetate, 1,8-cineole and limonene); and essential oils.

The inventors have found that the use of low boiling point solvents with high evaporation rates, as defined below by dry dosing, will be effective as carrier solvents. The inventors have also found that the use of higher boiling point solvents with lower evaporation rates, as defined below by wet dosing, leads to a preferred embodiment of the invention. In addition, the inventors of the present invention have surprisingly found that when wet dosing is employed and a solvent with a Snyder polarity index of less than approximately 4.0, preferably less than approximately 0.5, is chosen the release rates for the vapour active pyrethroid from the cellulosic based substrate are increased.

The cellulosic based substrate or matrix is impregnated and/or dosed with the vapour active pyrethroid, preferably metofluthrin, by way of dry or wet dosing.

By wet dosing, it is meant that the vapour active pyrethroid is applied to and carried within the cellulosic

based substrate or matrix in the presence of a carrier solvent. The vapour active pyrethroid, preferably metofluthrin, is dissolved in the carrier solvent and the resulting solution is applied to the cellulosic based substrate or matrix such that the vapour active pyrethroid is distributed, preferably evenly, throughout the cellulosic based substrate or matrix. The carrier solvent used in wet dosing is preferably a solvent that doesn't evaporate within approximately 10 minutes application onto the cellulosic based substrate or matrix and more preferably is characterised by having a high boiling point and a low evaporation rate.

Preferably, the carrier solvent for wet dosing has a boiling point in the range of approximately 120-330°C, more preferably approximately 150-265°C, and may be selected from known solvents including but not limited to normal paraffins with a boiling point range of about 155-276°C, such as Norpar 12; dearomatised aliphatic hydrocarbons and their blends in the boiling point range of about 150 -265°C such as Exxsol D40, Exxsol D80 and Exssol D100; isoparaffins in the boiling point range of about 150-300°C such as Isopar G and Isopar M and glycol ethers in the boiling point range of about 120-243°C.

In a preferred embodiment, the carrier solvent used in wet dosing has an evaporation rate according to ASTM D3539-87 of less than approximately 1.0, a boiling point in the range of approximately 150-265°C and a Snyder polarity index in the range of approximately 0.0-4.0, preferably approximately 0.0- 0.5.

It has been found that the release rate of the vapour active pyrethroid, preferably metofluthrin, from the cellulosic based substrate or matrix is reduced if the carrier solvent has an extremely high boiling point. For

instance, a carrier solvent having a boiling point within the range of about 285-317°C (eg Exxsol D140) has a lower release rate of vapour active pyrethroid into the atmosphere than carrier solvents having a boiling point within the range of about 150-265°C (eg Exxsol D40, Exxsol D80, Exxsol D100, Isopar G , Isopar M and Norpar 12).

By dry dosing, it is meant that the vapour active pyrethroid is applied to and present on the cellulosic based substrate or matrix in the presence of a volatile carrier solvent. Preferably, the vapour active pyrethroid, preferably metofluthrin, is dissolved in a volatile solvent which distributes the vapour active pyrethroid throughout the cellulose based substrate and then rapidly evaporates into the atmosphere. Preferably, the volatile solvent evenly distributes the vapour active pyrethroid onto the cellulosic substrate or matrix and will effectively evaporate within 10 minutes of application onto the cellulosic based substrate or matrix. More preferably, the carrier solvent is characterised by having a relatively low boiling point and a high evaporation rate. Even more preferably, the volatile solvent has an evaporation rate according to ASTM D3539-87 of greater than 1.0. Preferably, the volatile solvent is selected from known solvents including but not limited to chlorinated hydrocarbons, methanol, ethanol, pentane, hexane, heptane, acetone and mixtures of these solvents such as ethanol/acetone (1:1 by volume).

In a preferred embodiment of the invention in which dry dosing is employed, the vapour active pyrethroid, preferably metofluthrin, is dissolved in the volatile solvent and applied to the substrate, preferably a paper substrate, that will allow the solvent to evaporate at ambient temperature.

It will be understood that solvents used in both wet and dry application of the vapour active pyrethroid to the cellulosic based substrate or matrix may be employed as carrier solvents in all aspects of the present invention that require a carrier solvent.

The term "essential oils" will be understood to mean a volatile and aromatic liquid which is isolated by a physical process from an odoriferous plant of a single botanical species. The oil bears the name of the plant from which it is derived; for example rose oil or lavender oil. These essential oils obtained from plants may be extracted by distillation, steam distillation, expression or by extraction with fats or organic solvents.

It will be understood that "aroma chemicals" are natural isolates or synthetics which have an aroma. The natural isolates are removed mechanically (eg by distillation) or chemically (eg hydrolysis or salt formation) from a natural essential oil. The isolates are further modified. For example rose and lavender oils may be distilled to produce linalool, which may then be acetylated to make linalyl acetate. Aroma chemicals are the main constituents of essential oils. These constituents are generally monoterpenes and sesquiterpenes, including but not limited to alcohols, aldehydes, ketones, esters, oxides and hydrocarbons.

By "stable" insect control article according to the seventh and eighth aspects of the invention, it is meant that the active is stable in the cellulosic based substrate or matrix. More specifically, it will be understood that the insecticidal product will continue to be satisfactory in use after storage for at least 2 years according to the Manual on Development and Use of FAO and WHO Specification for Pesticides (first Edition, 2002).

Preferably, the packaged insect control article according to the fifth and sixth aspects of the invention are stable articles.

In the third and fourth aspects of the invention, directed to an flying insect control article, the cellulosic based substrate or matrix is attached to a protective material. In preferred embodiments of the first, second, fifth, sixth, seventh and eighth aspects of the invention, the cellulosic based substrate or matrix may be attached to a protective material. It will be understood that the meaning of the word "attached" includes but is not limited to joined, fastened, connected, annexed or affixed. Accordingly, it will be understood that the cellulosic based substrate or matrix may be attached to the protective material directly or indirectly. In a preferred embodiment of the invention, the cellulosic matrix or substrate has one or two ends that are attached to a backing board that has a protective material on one side. It will be understood that the cellulosic matrix or substrate may be attached directly to the side of the backing board with the protective material, or attached to the side of the backing board that does not have the protective material, thereby being indirectly attached to the protective material. By way of non-limiting example, it will be appreciated that the protective material may be "attached to" the cellulosic substrate or matrix by way of water and solvent based glues, hot-melt adhesives, staples, adhesive tapes and Velcro fasteners.

As discussed below, the cellulosic based substrate or matrix of the invention may be in a closed or open form. When the cellulosic based substrate or matrix is attached to a protective material and is in a closed form, the protective material preferably covers the cellulosic

substrate or matrix to minimise emanation of the vapour active pyrethroid into the environment. When the cellulosic based substrate or matrix is enclosed in a packaging material as defined in the fifth, sixth, seventh and eighth aspects of the invention, the cellulosic based substrate or matrix is preferably in a closed form.

It will be appreciated that once the cellulosic based substrate or matrix is impregnated/dosed with the vapour active pyrethroid it may need to be stored for significant periods of time. It is therefore important that the packaging material or protective material is effective in minimising the release/emanation rate of vapour active pyrethroid from the cellulosic based substrate or matrix into the atmosphere. This is most successfully achieved when the packaging material or protective material is a material through which the vapour active pyrethroid will not migrate and/or be absorbed.

Preferably, the packaging/protective material used in the present invention is selected from but not limited to glass; metal foil, preferably aluminium foil, and laminates thereof; polyester, metalised polyester, heat sealable polyester film, polyester based film and formed sheet, such as amorphous PET and crystalline PET, and laminates thereof; and acrylonitrile-methyl acrylate copolymers and laminates thereof.

It has been found that when the cellulosic based substrate or matrix is wet dosed, a greater range of packaging material and protective material can be used than if the cellulosic based substrate or matrix was dry dosed. The present inventors have surprisingly found that wet dosing the cellulosic based substrate or matrix effects the movement of vapour active pyrethroid into the packaging and protective material. In particular, the

inventors have found that the movement of vapour active pyrethroid into some material, such as glass; metal foil and laminates thereof; polyester, metalised polyester, heat sealable polyester film, polyester based film and formed sheet, such as amorphous PET and crystalline PET, and laminates thereof; and acrylonitrile-methyl acrylate copolymers and laminates thereof; is reduced if wet dosing rather than dry dosing is employed.

Without being bound by theory, it is thought that in wet dosing, the vapour active pyrethroid has an affinity for the solvent and is less likely to migrate from the cellulose based substrate or matrix. In contrast, it is thought that when dry dosing is employed, the vapour active pyrethroid is absorbed by the substrate or matrix and results in migration of the vapour active pyrethroid into the and through some materials.

Preferably, the packaging/protective material used in the present invention when dry dosing is employed is selected from but not limited to metal foil, glass and crystalline PET. Preferably, the packaging/protective material used in the present invention when wet dosing is employed is selected from but not limited to glass; metal foil and laminates thereof; metalised polyester, heat sealable polyester film, polyester, polyester based film and formed sheet, such as amorphous PET and crystalline PET, and laminates thereof; and acrylonitrile-methyl acrylate copolymers, and laminates thereof. Even more preferably, the packaging/protective material used is laminated metal foil.

As noted above, the emanation rate of the vapour active pyrethroid from the cellulosic based substrate or matrix is affected by a number of parameters including surface area, paper mass and size, the number of folds

etc. This in turn means that products effective in killing and/or repelling insects over different time periods, such as for 12 h and 300 h, could be different.

Air movement is required in order for the pyrethroid to emanate from the substrate into the atmosphere. The rate of emanation increases with increased air flow. A minimal air flow, such as the movement of bodies, a small fan in a closed room or open windows and/or doors, is sufficient to allow a minimum emanation rate of approximately 0.040 mg/h, and the preferred emanation rate of approximately 0.075 mg/h.

The cellulosic based substrate or matrix of the invention containing the vapour active pyrethroid may be folded between an open form and a closed form such that they are expandable and re-closable arrangements. This means that when insect control is not required, the cellulosic based substrate or matrix may be closed and stored in a form which minimises the surface area containing the vapour active pyrethroid that is exposed to the atmosphere. Conversely, when insect control is required, the cellulosic based substrate or matrix may be expanded into an open form thereby increasing the surface area of cellulosic based substrate or matrix containing the pyrethroid that is exposed to the atmosphere allowing the pyrethroid to emanate into the atmosphere.

It will be appreciated that various configurations of the cellulosic based substrate or matrix may be adopted. These configurations include but are not limited to Japanese fans, concertina type arrangements and three dimensional structures having a plurality of cells such as honeycomb like arrangements that open and close in a concertina like fashion.

A honeycomb type arrangement may be hung to give a linear configuration, opened on a table to provide a bridge configuration or closed into a circle to give a hanging lantern configuration. It will be appreciated that in forming the circular hanging lantern other configurations prior to the circular form may be adopted. For instance, the honeycomb arrangement may be positioned in an arc of up to 360°. Preferably the cellulosic based substrate or matrix is a honeycomb arrangement made of paper.

In a preferred embodiment of the invention, the cellulosic substrate or matrix is in the form of a paper honeycomb arrangement with two ends. Preferably, the two ends of the honeycomb arrangement are attached to protective material through which the vapour active pyrethroid cannot migrate and/or be absorbed. More preferably, the two ends of the honeycomb arrangement are attached to cardboard laminated with foil, even more preferably, the cellulosic based substrate or matrix forming the honeycomb arrangement and impregnated and/or dosed with the vapour active pyrethroid is attached to the foil side of the cardboard using water based glue.

In a preferred embodiment of the invention, the cellulosic based substrate or matrix is a refill unit for a holding unit that is able to support the cellulosic based substrate or matrix. For instance, the holding unit containing the cellulosic based substrate or matrix may be hung or laid on a table.

The tenth aspect of the invention is directed to a method of packaging cellulosic based substrate or matrix or insect control article according to the invention. It will be appreciated that the forming filling and sealing

steps can be carried out according to a number of known procedures.

Brief Description of Drawings

Figure 1 is a bar graph showing % knockdown of *Aedes aegypti* mosquitoes in a 40 m^3 test chamber when exposed to various sizes of 18 gsm paper dosed with 150 mg of metofluthrin.

Figure 2 is a bar graph showing % knockdown of *Aedes aegypti* mosquitoes knockdown in a 40 m^3 test chamber when exposed to various sizes of 18 gsm paper dosed with the same concentration of metofluthrin per square metre (100 mg on A4, 50 mg on A5, 25 mg on A6, 12.5 mg on A7 and 6.25 mg on A8).

Figure 3 is a bar graph showing the affect of aging at 28°C of A4 paper dosed with 2 mg of metofluthrin on the % knockdown of *Aedes aegypti* mosquitoes in a 40 m^3 test chamber.

Figure 4 is a graph showing the combined emanation profile of 14, 20 and 25 mg of metofluthrin from bleached paper (A4, 50 gsm).

Figure 5 is a graph showing the emanation rate of metofluthrin from a honeycomb configuration at 28°C.

Figure 6 is a one cell honeycomb configuration with a surface area of 2bc+2bd+4ab

Modes for carrying out the Invention

In order to understand better the nature of the invention, a number of examples will now be described.

A) Paper size and Surface Area:

A-series paper sizes:	Surface Area
A1 - 5000 cm^2 - 0.5 m^2	1 m^2
A2 - 2500 cm^2 - 0.25 m^2	0.5 m^2
A3 - 1250 cm^2 - 0.125 m^2	0.25m^2
A4 - 625 cm^2 - 0.0625 m^2	0.125m^2
A5 - 312 cm^2 - 0.03125 m^2	0.0625m^2
A6 - 156 cm^2 - 0.01563 m^2	0.03126m^2
A7 - 78.1 cm^2 - 0.00781 m^2	0.01562m^2
A8 - 39.1 cm^2 - 0.00391 m^2	0.00782m^2

B) Calculating the surface area:

Example 1 - where the cellulosic based substrate or matrix is a sheet of flat A4 paper:

The surface area of the flat A4 paper is the sum of the area of both sides of the paper and is calculated as follows:

Surface area = area of one side of paper + area of other side of paper

Surface area = 625 cm^2+625 cm^2

Surface area =1250 cm^2

Example 2 - where the cellulosic based substrate or matrix is a honeycomb configuration according to Figure 5

Figure 5 shows one cell of a honeycomb configuration. The surface area of the cell shown in Figure 5 is the sum of the area of the surfaces exposed to air. There are glue lines between surface 1 and 2 and between surface 5 and 6 which means that each portion of paper forming these surfaces only has one side exposed to air. The portions of

paper forming surfaces 3, 4, 7 and 8 all have two sides exposed to air. Accordingly, the surface area for the cell shown in Figure 5 is calculated as follows:

Surface area (SA)=(SA of surface 1) + (SA of surface 2) + (SA of surface 5) + (SA of surface 6) + (SA of surface 3)x2 + (SA of surface 4)x2 + (SA of surface 7)x2 + (SA of surface 8)x2

Surface area = bc + bc +bd + bd +4 (ab)

Surface area =2bc + 2bd + 4ab

C) Knockdown Studies

The inventors have carried out a number of knockdown studies for the control of mosquitoes using paper surfaces impregnated and/or dosed with the vapour active insecticide metofluthrin. The active was applied to each paper surface as a solution in acetone/ethanol (1:1).

Tests were carried out in a 40m^3 test chamber. The temperature was approximately 28°C. Mixed sex *Aedes aegypti* mosquitoes were used, aged for 7-10 days after emergence. Up to 200 mosquitoes were introduced into the chamber for each test. Three replicates were done for each treatment. Knocked down mosquitoes were collected at the end of each assessment period and counted.

Example 3:

Knockdown studies against the Dengue mosquito *Aedes aegypti* using three surface areas a) A2, b) A3 and c) A4 of 18 gsm paper in the above test chamber were carried out. Each paper was treated with 150 mg of metofluthrin. A mosquito coil containing 0.04% Prallethrin was included as a reference control. The results are shown in Figure 1.

The results show that after 10 minutes, an increase in surface area increases product performance. After 20 minutes, all surface areas were equally effective.

Further, it shows that all three paper sizes when treated with metofluthrin are more effective than the control.

Example 4

Knockdown studies were carried out in the above test chamber against the Dengue mosquito *Aedes aegypti* using five surface areas of 18 gsm paper with five varying doses of metofluthrin a) A4, 100 mg, b) A5, 50 mg, c) A6, 25 mg, d) A7, 12.5 mg, and e) A8, 6.25 mg.

There was a common concentration of 800 mg/m^2 for all paper samples. A mosquito coil containing 0.04% prallethrin was included as a reference control. The treated paper was hung in the centre of the above chamber. The results are shown in Figure 2.

The results show that an increase in surface area generally increases product performance. The inventors have concluded that the performance is dependent upon the surface area.

Example 5

A knockdown study against the Dengue mosquito *Aedes aegypti* using aged paper was conducted. The test involved treating 18 gsm paper of A4 surface area with 2 mg of metofluthrin at 28°C for up to 12 hours. The treated paper was hung in the centre of the above chamber. A mosquito coil containing 0.04% prallethrin was included in the trial as a reference control.

The results are shown in Figure 3.

The results show that 2 mg of metofluthrin is required on the treated substrate to achieve greater than 40% knockdown for up to 4 hours. At 4 hours, the substrate of the present invention is twice as effective as the control.

D) Studies involving Emanation Rate

Example 6:

A study involving dosing 50 gsm paper with different amounts of metofluthrin was made to investigate the affect on the emanation rate from this substrate.

Three samples of white (A4) paper (50 gsm) each having a surface area of 1250 cm^2 were dosed with metofluthrin (25, 20 and 14 mg) dissolved in acetone/ethanol (1:1) using the dry dosing technique. The papers were aged in a chamber at 28°C with low air flow for up to a maximum of 214 hours. The amount of metofluthrin remaining on the paper substrate was measured from time 0 hours to 214 hours. The plot obtained for the emanation rate of metofluthrin from the 25 mg dosed samples was used to estimate the time it would take for 20 and 14 mg of metofluthrin to remain on the samples. A combined plot of the data is shown in Figure 4.

The inventors have concluded that by varying the initial amount of metofluthrin dosed on to the paper (A4) substrate in the range of 25 mg to approximately 5 mg, the emanation rate is constant. The results also demonstrate that linear release kinetics is observed for metofluthrin emanating from paper substrates. The combined plot enables an average release rate to be determined by fitting a line of best fit to the data so that the average rate of emanation to be determined.

Example 7

A study involving dosing 18 gsm paper configured into a honeycomb format with an estimated surface area of 2199 cm^2 with metofluthrin (30 mg) was made to determine the emanation rate from this substrate.

The metofluthrin was dissolved in Norpar 12 and dosed on to the substrate using the wet dosing technique. The papers were hung and aged in a chamber at 28°C with low airflow for up to a maximum of 80 hours. The amount of metofluthrin remaining on the paper substrate was measured from time 0 hours to 80 hours. The plot obtained for the amount of metofluthrin remaining on samples as a function of time was used to calculate the release rate from this format. A plot of the data is shown in Figure 5.

The inventors have concluded that an emanation rate of 0.22 mg/hr (at 28°C) can be achieved from an 18 gsm honeycomb configuration of estimated surface area of 2199 cm^2. The results also demonstrate that linear release kinetics is observed for metofluthrin emanating from this format.

Example 8

A study of the metofluthrin emanation rate from 30 gsm paper dosed with different solvents was made.

White (A4) paper (30 gsm) having a surface area of 1250 cm^3 was dosed with metofluthrin (14 mg) prepared in a range of solvents, as listed below. The papers were aged in a chamber at 28°C with low air flow for up to a maximum of 168 hours. The amount of metofluthrin remaining on the paper substrate was measured from time 0 hours to 168 hours. The following solvents were used:

Solvent	Chemical Description	Supplier/Source
Exxsol D80	Dearomatised aliphatic hydrocarbon	Exxon Mobil (Australia)
Exxsol D40	Dearomatised aliphatic hydrocarbon	Exxon Mobil (Australia)
Isopar G	Isoparaffins	Exxon Mobil (Australia)
HoTung C11-14	Normal paraffins	Ho Tung (China)
Acetone/ethanol (1:1)	Ketone/alcohol mixture	Laboratory reagent
Exxsol D140	Dearomatised aliphatic hydrocarbon	Exxon Mobil (Singapore)

Table 1 summarises the observed emanation rates for each solvent. The inventors have concluded that linear release kinetics are observed for metofluthrin emanating from paper substrates and accordingly, the line of best fit was fitted to obtain the linear equation to enable the rate of emanation to be determined.:

Table 1:

Solvents used for dosing	wet/dry dosing	Solvent Specifications			Release Rate Index***
		Boiling Range (°C)	Evaporation Rate*	Polarity Index**	
acetone/ethanol	dry	56-78	2.3-5.7	4.3-5.1	1.00
Exxsol D80	wet	201-245	0.02	~0.1-0.4	1.41
Exxsol D40	wet	155-196	0.15	~0.1-0.4	1.40
Isopar G	wet	155-175	0.16-0.28	~0.1-0.4	1.58

HoTung C11-14	wet	185-221	0.04	~0.1-0.4	1.37
Exxsol D140	wet	285-317	<0.01	~0.1-0.4	0.25

* Relative to n-butyl acetate = 1 (ASTM D3539-87)

** According to the Snyder polarity index for solvents (L.R.Snyder, J Chromatographic Science, 1978, <u>16</u>, 223) (Reference compounds; *i*-octane = 0.1, *n*-decane = 0.4, *n*-hexane = 0.1)

*** The release rate index is determined from the observed release rate of metofluthrin from substrates dosed in a solvent relative to the release rate for the samples dosed with metofluthrin in acetone/ethanol (1:1 by volume).

The results indicate that papers dosed with metofluthrin in solvents with boiling ranges from 155 - 245°C show an increase in release rate compared to the acetone/ethanol control. Further, extremely high boiling point solvents such as Exxsol D140 cause a drastic reduction in the release rate. In these samples the solvent did not completely evaporate during the study.

In addition, it is observed that solvents with boiling ranges from 155 - 245°C and relatively low polarity indexes show an increased release rate compared to the sample dosed with acetone/ethanol (1:1) which has a comparatively high polarity index.

Example 9

A study of the metofluthrin emanation rate from 18 gsm paper dosed with different solvents was made.

Tissue paper (18 gsm) having an effective surface area of 1250 cm^2 (A4) was dosed with metofluthrin (14 mg) prepared in a range of solvents. The papers were then aged in a chamber at 28°C with low airflow for up to a maximum of 168 hours. The amount of metofluthrin remaining on the paper substrate was measured from time 0 hours to 168 hours. The following solvents were used:

Solvent	Chemical Description	Supplier/Source
Acetone/ethanol (1:1 by volume)	Ketone/alcohol mixture	Laboratory reagent
n-pentane	n-pentane	Laboratory reagent
Sasol C12-13	Normal paraffins	Schumann Sasol
Isopar L	Isoparaffins	Exxon Mobil (Australia)
Dowanol DPM	Glycol ether	Dow Chemicals (Australia)
Dowanol TPM	Glycol ether	Dow Chemicals (Australia)

Table 2 illustrates the observed emanation rates for each solvent. The inventors have concluded that linear release kinetics are observed for metofluthrin emanating from paper substrates and accordingly, the line of best fit was fitted to obtain the linear equation to enable the rate of emanation to be determined. :

Table 2:

Solvents used for dosing	dry/wet dosing	Solvent Specifications			Release Rate Index ***
		Boiling Range (°C)	Evaporation Rate *	Polarity Index **	
acetone/ethanol	dry	56 - 78	2.3-5.7	4.3-5.1	1.00
n-pentane	dry	36	>33	0.0	1.50
Sasol C12-13	wet	188 - 219	0.04	~0.1 - 0.4	1.63
Isopar L	wet	190 - 207	????	~0.1 - 0.4	1.75
Dowanol DPM	wet	190	0.035	>~2	1.20
Dowanol TPM	wet	243	0.0026	>~2	1.24

* Relative to n-butyl acetate = 1 (ASTM D3539-87)

** According to the Snyder polarity index for solvents (Reference compounds; *i*-octane = 0.1, *n*-decane = 0.4, *n*-hexane = 0.1, glycols >~2

*** The release rate index is determined from the observed release rate of metofluthrin from substrates dosed in a solvent relative to the release rate for the samples dosed with metofluthrin in (acetone/ethanol (1:1)).

The results indicate that papers dosed with metofluthrin in solvents with boiling ranges from 188 - 243°C show an increase in release rate compared to the acetone/ethanol control. In addition, it is observed that samples dosed with solvents that have low polarity indexes show significantly increased release rates compared to the sample dosed with acetone/ethanol (1:1) which has a comparatively high polarity index.

The results show that increases in release rate may be a result of a combination of the two parameters, volatility and polarity. The results for n-pentane and the Dowanols indicate that the polarity of the solvent has a stronger influence on release rate than volatility.

Example 10:

The stability and packaging suitability of various materials was studied. In these studies, metofluthrin (14 mg) was applied to A4 sized 30 gsm paper substrates via wet and dry application at ambient temperature. The samples were placed in pouches prepared from the packaging materials under investigation, sealed tightly and stored at 55°C. After periods of one and two weeks, samples were removed from storage and the dosed paper substrates were measured for metofluthrin content. The packaging materials studied were glass, PVC, amorphous PET (APET), crystalline PET (CPET), aluminium foil, heat sealable polyester films, acrylonitrile methyl acrylate copolymer and PEPET. For the wet dosing of metofluthrin on the paper substrate, the metofluthrin was dissolved in Exxsol D80 or Norpar 12 and the resulting solution applied to the substrate. For dry application, the metofluthrin was dissolved in acetone/ethanol (1:1 by volume) and applied to the substrate. The solvent was then allowed to evaporate over a period of 5-10 minutes.

The following table summarises the results obtained:

Packaging Material	WET DOSING Solvent; a = Exxsol D80 b = Norpar 12		DRY DOSING Solvent; c = acetone/ethanol (1:1)	
	metofluthrin recovered from paper substrate (%)		metofluthrin recovered from paper substrate (%)	
	1 week at 55°C	2 weeks at 55°C	1 week at 55°C	2 weeks at 55°C
Glass (bottle) [a, c]	100	98	90	81
PVC [a, c]	73	44	64	46
APET [a, c]	95	100	87	82
CPET [a, c]	96	100	98	99
Aluminium foil [a, c]	99	100	99	98
heat sealable polyester films [a, c]	-	100	-	92
Acrylonitrile methyl acrylate copolymer [b, c]	98	99	-	-
EPET [b, c]	78	77	-	-

Note 1: The glass bottle included a PET lid. The lid has been attributed to the loss of metofluthrin observed from the stability experiment when using the dry dosing method.

Note 2: It should be recognised that an acceptable level of uncertainty for these measurements would be ± 5 %

The results indicate that packing the product wet limits the movement of the active into the packaging. Further, APET, CPET, glass, heat sealable polyester film, acrylonitrile methyl acrylate copolymer and aluminium foil all appear suitable packaging for wet packaged product. If the product is to be packed dry then CPET and aluminium foil appear to be better packaging options.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

CLAIMS:

1. A packaging means for retaining vapour active pyrethroids comprising a holder and a cellulosic based substrate or matrix impregnated and/or dosed with the vapour active pyrethroid,

wherein the holder comprises a top, a base and a longitudinal member vertically extending from between the top and base, and

wherein the cellulosic based substrate or matrix has a honeycomb configuration adapted to be retained between the top and base and has a surface area so as to achieve sufficient emanation of the vapour active pyrethroid to control flying insects.

2. A packaging means for retaining vapour active pyrethroids comprising a holder and a cellulosic based substrate or matrix impregnated and/or dosed with the vapour active pyrethroid, wherein the holder comprises a top, a base and a longitudinal member vertically extending from between the top and base, and wherein the cellulosic matrix has a honeycomb configuration adapted to be retained between the top and base and has a surface area so as to achieve sufficient emanation of the vapour active pyrethroid to control flying insects, and wherein the cellulosic substrate or matrix is comprised of two or more discrete parts.

3. The packaging means according to claim 2 wherein the cellulosic substrate is comprised of two parts.

4. The packaging means according to claim 3 wherein the two parts are of substantially identical dimensions.

5. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or

matrix has a surface area of about 50 - 5000 cm^2 and a height of about 8 - 23 cm.

6. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix has a surface area of about 50 - 5000 cm^2 and a height of about 17.5 cm.

7. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix has a surface area of about 180 - 2400 cm^2 and a height of about 8 - 23 cm.

8. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix has a surface area of about 180-2400 cm^2 and a height of about 17.5 cm.

9. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix has a grammage of about 12 - 260 gsm.

10. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix has a grammage of about 18 - 40 gsm

11. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix has a grammage of about 18 gsm.

12. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 2-3000 mg/m^2 of surface area.

13. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 16 - 320 mg/m^2 of surface area.

14. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 130-320 mg/m^2 of surface area

15. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 48-960 mg/m^2 of surface area.

16. The packaging means according any one of the preceding claims wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 390-960 mg/m^2 of surface area.

17. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 144-2880 mg/m^2 of surface area.

18. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 1170-2880 mg/m^2 of surface area.

19. The packaging means according to any one of the preceding claims wherein the longitudinal member is releasably attachable to the top, base or both of the top and base.

20. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix, or the longitudinal vertically extending member, or both, are capable of being extended so that the top and base are in an open state or collapsed so that the top and base are in a closed state.

21. The packaging means according to claim 20 wherein the open state allows the vapour active pyrethroid to emanate into the atmosphere.

22. The packaging means according to claim 20 wherein the closed state substantially seals the cellulosic based substrate or matrix so that a minimal amount of vapour active pyrethroid is emanated into the atmosphere.

23. The packaging means according to claim 20 wherein the top and base are capable of being maintained in an intermediate state between the open and closed states thereby allowing the amount of surface area of the cellulosic based substrate or matrix exposed to the atmosphere to be controlled resulting in the control of the amount of vapour active pyrethroid emanated.

24. The packaging means according to any one of the preceding claims wherein the longitudinal member vertically extending between the top and the base is a column.

25. The packaging means according to claim 24 wherein the column is collapsible by folding at one or more hinged joints.

26. The packaging means according to claim 24 or claim 25 wherein the column is comprised of one or more parts and is collapsible by telescopic movement of the one or more parts of the column within the other parts of the column.

27. The packaging means according to any one of claims 24 to 26 wherein the column is comprised of two or more interfitting parts.

28. The packaging means according to any one of claims 24 to 27 wherein the column is comprised of two or more releasable interfitting parts.

29. The packaging means according to any one of claims 24 to 27 wherein the column is comprised of two or more non-releasable interfitting parts.

30. The packaging means according to claim 27 wherein the parts are able to be interfitted by means of a slotted configuration wherein each respective part comprises a slot which fits into the slot of another one or more parts.

31. The packaging means according to any one of claims 24 to 30 wherein the top is adapted to receive the column through an aperture thereby allowing the top to be moved along the column by a sliding motion so that the holder is able to be opened by sliding the top away from the base or closed by sliding the top towards the base.

32. The packaging means according to any one of the preceding claims wherein the longitudinal member

vertically extending between the top and the base is a spring.

33. The packaging means according to claim 32 wherein the spring is compressed in the resting state so that the cellulosic based substrate or matrix is maintained in a collapsed state in the absence of an externally applied force.

34. The packaging means according to claim 32 or claim 33 wherein the spring is uncompressed in the resting state so that the cellulosic based substrate or matrix is maintained in an extended state in the absence of an externally applied force.

35. The packaging means according to any one of the preceding claims wherein the holder and cellulosic based substrate or matrix are adapted to allow the cellulosic matrix to be releasably retained in the holder and replaced as required.

36. The packaging means according to any one of the preceding claims wherein the holder comprises a slot within the periphery of each of the top and base and the cellulosic based substrate or matrix comprises a card on each of its ends, wherein the cards are able to be slid within the slots thereby allowing the cellulosic based substrate or matrix to be releasably retained in the holder.

37. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix is adapted to receive the longitudinal member through an aperture thereby retaining the cellulosic based substrate or matrix between the top and base.

38. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix is able to be replaced by detaching the top or base, or both, from the longitudinal member, mounting the cellulosic based substrate or matrix about the longitudinal member, and reattaching the top or base, or both, to the longitudinal member.

39. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix is able to be removed and replaced without the need to detach either the top or base from the longitudinal member.

40. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix is able to be removed and replaced while the top and base are in a closed position.

41. The packaging means according to any one of the preceding claims wherein the longitudinal member is capable of being stored within the packaging means when the top and base are in a closed position.

42. The packaging means according to any one of the preceding claims wherein the top further comprises a protruding rim and wherein the base has a means for engaging the protruding rim to substantially seal the vapour active pyrethroid when the top and base are in the closed state.

43. The packaging means according to any one of the preceding claims wherein the top is a lid.

44. The packaging means according to any one of the preceding claims further comprising an end-of-life (EOL)

indicator comprising a counter, an indicator display located on the counter and a gear mechanism adapted to rotate the counter one increment each time the packaging means is extended from a closed position to an open position and/or collapsed from an open position to a closed position, such that a user is able to ascertain from the display when the packaging means is substantially depleted in vapour active pyrethroid thereby having reached its EOL.

45. The packaging means according to claim 44 wherein the indicator display is a numeric or colour graphic display.

46. The packaging means according to any one of the preceding claims wherein the cellulosic based substrate or matrix is attached to the top and base, wherein the base is able to be surface mounted and is connected to the longitudinal member having a hook on its end, and wherein the cellulosic substrate or matrix is able to be extended and supported in the extended state by attachment of the top to the hook.

47. A cellulosic based substrate or matrix having a honeycomb structure that when in an extended state, has a surface area of about 50 - 5000 cm^2 and a height of about 8 - 23 cm.

48. The cellulosic based substrate or matrix according to claim 47 having a honeycomb structure that when in an extended state, has a surface area of about 50 - 5000 cm^2 and a height of about 17.5 cm.

49. A cellulosic based substrate or matrix according to claim 47 or claim 48 having a honeycomb structure that when in an extended state, has a surface area of about 180 - 2400 cm^2 and a height of about 8 - 23 cm.

50. The cellulosic based substrate or matrix according to any one of claims 47 to 49 having a honeycomb structure that when in an extended state, has a surface area of about 180 - 2400 cm^2 and a height of about 17.5 cm.

51. The cellulosic based substrate or matrix according any one of claims 47 to 50 having a grammage of about 12 - 260 gsm.

52. The cellulosic based substrate or matrix according to any one of claims 47 to 51 having a grammage of about 18 - 40 gsm.

53. The cellulosic based substrate or matrix according to any one of claims 47 to 52 having a grammage of about 18 gsm.

54. A method of emanating a vapour active pyrethroid into the atmosphere by the use of a packaging means for retaining vapour active pyrethroids comprising a holder and a cellulosic based substrate or matrix impregnated and/or dosed with the vapour active pyrethroid,

wherein the holder comprises a top, a base and a longitudinal member vertically extending from between the top and base, and

wherein the cellulosic based substrate or matrix has a honeycomb configuration adapted to be retained between the top and base and has a surface area so as to achieve sufficient emanation of the vapour active pyrethroid to control flying insects.

55. The method according to claim 54 wherein the cellulosic based substrate or matrix has a surface area of about 50 - 5000 cm^2 and a height of about 8 - 23 cm.

56. The method according to claim 54 or 55 wherein the cellulosic based substrate or matrix has a surface area of about 50 - 5000 cm^2 and a height of about 17.5 cm.

57. The method according to any one of claims 54 to 56 wherein the cellulosic based substrate or matrix has a surface area of about 180 - 2400 cm^2 and a height of about 8 - 23 cm.

58. The method according to any one of claims 54 to 57 wherein the cellulosic based substrate or matrix has a surface area of about 180 - 2400 cm^2 and a height of about 17.5 cm.

59. The method according to any one of claims 54 to 58 wherein the cellulosic based substrate or matrix has a grammage of about 12 - 260 gsm.

60. The method according to any one of claims 54 to 59 wherein the cellulosic based substrate or matrix has a grammage of about 18 - 40 gsm.

61. The method according to any one of claims 54 to 60 wherein the cellulosic based substrate or matrix has a grammage of about 18 gsm.

62. The method according to any one of claims 54 to 61 wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 2-3000 mg/m^2 of surface area.

63. The method according to any one of claims 54 to 62 wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 16-320 mg/m^2 of surface area.

64. The method according to any one of claims 54 to 63 wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 130-320 mg/m^2 of surface area.

65. The method according to any one of claims 54 to 64 wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 48-960 mg/m^2 of surface area.

66. The method according to any one of claims 54 to 63 wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 390-960 mg/m^2 of surface area.

67. The method according to any one of claims 54 to 66 wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 144-2880 mg/m^2 of surface area.

68. The method according to any one of claims 54 to 67 wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 1170-2880 mg/m^2 of surface area.

69. The method according to any one of claims 54 to 68 for controlling any one of mosquitoes, flies, gnats, sandflies, midges, moths.

70. The method according to any one of claims 54 to 69 for controlling mosquitoes.

71. The use of a packaging means for retaining and emanating vapour active pyrethroids comprising a holder and a cellulosic based substrate or matrix impregnated and/or dosed with the vapour active pyrethroid,

wherein the holder comprises a top, a base and a longitudinal member vertically extending from between the top and base, and

wherein the cellulosic based substrate or matrix has a honeycomb configuration adapted to be retained between the top and base and has a surface area so as to achieve sufficient emanation of the vapour active pyrethroid to repel insects.

72. The use according to claim 71 wherein the cellulosic based substrate or matrix has a surface area of about 50 - 5000 cm^2 and a height of about 8 - 23 cm.

73. The use according to claim 71 or claim 72 wherein the cellulosic based substrate or matrix has a surface area of about 50 - 5000 cm^2 and a height of about 17.5 cm.

74. The use according to any one of claims 71 to 73 wherein the cellulosic based substrate or matrix has a surface area of about 180 - 2400 cm^2 and a height of about 8 - 23 cm.

75. The use according to any one of claims 71 to 74 wherein the cellulosic based substrate or matrix has a surface area of about 180 -2400 cm^2 and a height of about 17.5 cm.

76. The use according to any one of claims 71 to 75 wherein the cellulosic based substrate or matrix has a grammage of about 12 - 260 gsm.

77. The use according to any one of claims 71 to 76 wherein the cellulosic based substrate or matrix has a grammage of about 18 - 40 gsm.

78. The use according to any one of claims 71 to 77 wherein the cellulosic based substrate or matrix has a grammage of about 18 gsm.

79. The use according to any one of claims 71 to 78 wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 2-3000 mg/m^2 of surface area.

80. The use according to any one of claims 71 to 79 wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 16-320 mg/m^2 of surface area.

81. The use according to any one of claims 71 to 80 wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 130-320 mg/m^2 of surface area.

82. The use according to any one of claims 71 to 81 wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 48-960 mg/m^2 of surface area.

83. The use according to any one of claims 71 to 82 wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 390-960 mg/m^2 of surface area.

84. The use according to any one of claims 71 to 83 wherein the cellulosic based substrate or matrix is impregnated and/or dosed with vapour active pyrethroid in an amount of about 144-2880 mg/m^2 of surface area.

85. The use according to any one of claims 71 to 84 wherein the cellulosic based substrate or matrix is

impregnated and/or dosed with vapour active pyrethroid in an amount of about 1170-2880 mg/m^2 of surface area.

86. The use of the packaging means of any one of claims 71 to 85 for controlling any one of mosquitoes, flies, gnats, sandflies, midges, moths.

87. The use of the packaging means of any one of claims 71 to 86 for controlling mosquitoes.

88. An indicator for indicating the end-of-life (EOL) of a packaging means for retaining and emanating a vapour active pyrethroid comprising a counter, an indicator display located on the counter and a gear mechanism adapted to rotate the counter one increment each time the packaging means is extended from closed position to an open position such that a user is able to ascertain from the display when the packaging means is substantially depleted in vapour active pyrethroid thereby having reached the EOL.

89. The indicator of claim 88 wherein the gear mechanism is adapted to rotate the counter one increment each time the packaging means is collapsed from an open position to a closed position.

90. The indicator of claim 88 or claim 89 wherein the gear mechanism is adapted to rotate the counter one increment each time the packaging means is extended from an open position to a closed position and collapsed from an open position to a closed position.

91. The indicator according to any one of claims 88 to 90 wherein the indication is by means of a graphic display.

92. The indicator according to claim 91 wherein the graphic display comprises a change in colour as an indicator of EOL.

93. The indicator according to claim 91 wherein the graphic display comprises a gradation in colour as an indicator of EOL.

94. The indicator according to claim 91 wherein the graphic display comprises a numerical display as an indicator of EOL.

95. The indicator according to claim 91 wherein the graphic display comprises a series of dots of changing size as an indicator of EOL.

96. The indicator according to any one of claims 88 to 95 wherein the user is able to set the EOL indicator to a desired EOL period.

97. The indicator according to any one of claims 88 to 96 wherein the user is able to reset the EOL indicator.

ABSTRACT

Packaging means for emanating pyrethroid effective in controlling flying insects

The invention provides a packaging means for retaining vapour active pyrethroids comprising a holder and a cellulosic based substrate or matrix impregnated and/or dosed with the vapour active pyrethroid,

wherein the holder comprises a top, a base and a longitudinal member vertically extending from between the top and base, and

wherein the cellulosic matrix has a honeycomb configuration adapted to be retained between the top and base and has a surface area so as to achieve sufficient emanation of the vapour active pyrethroid to control flying insects.

The invention also provides methods of emanating vapour active pyrethroids and the use of packaging means according to the invention for retaining and emanating vapour active pyrethroids.

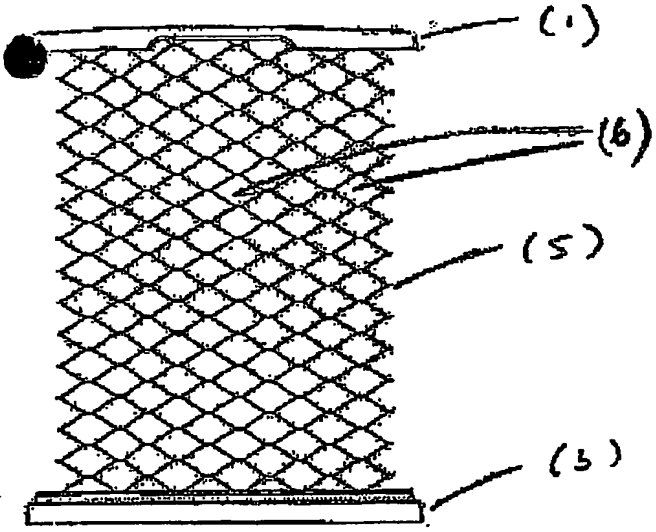


FIGURE 1

clip_exploded

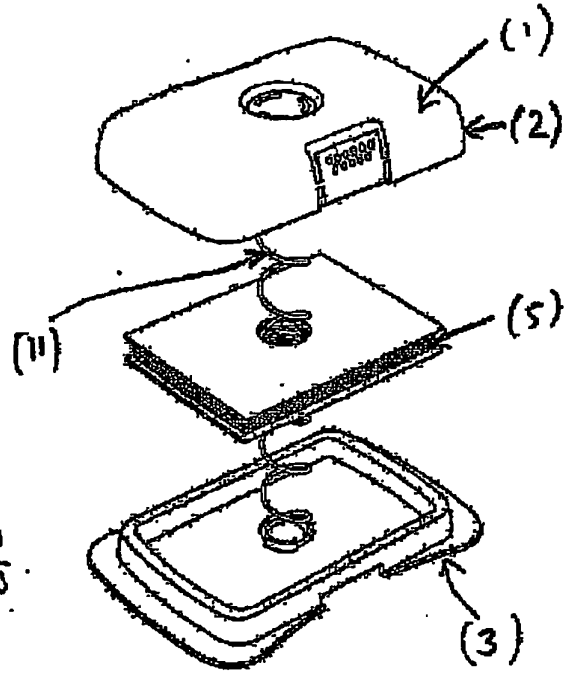
FIGURE 2(a)

clip_open

FIGURE 2(b)

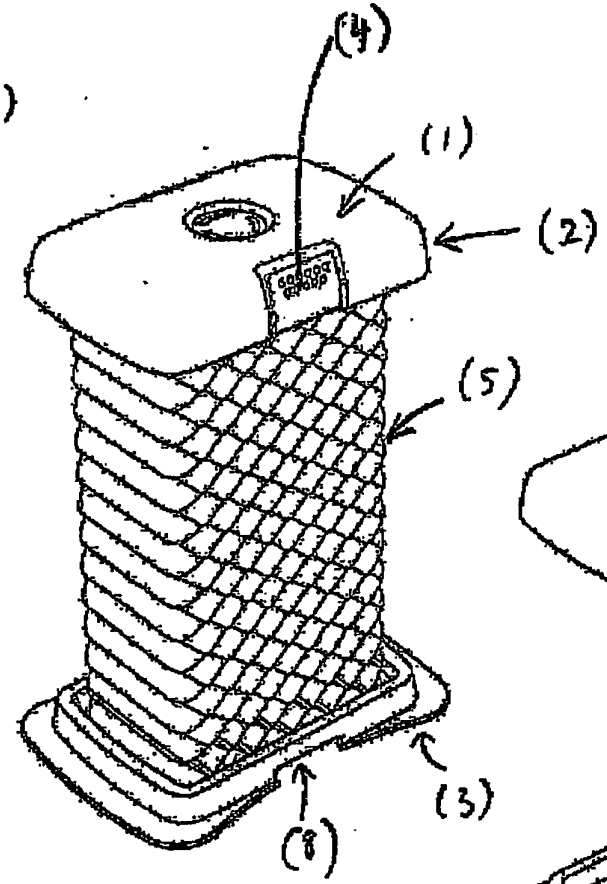
clip_open_no_paper

FIGURE 2(c)



spring_exploded

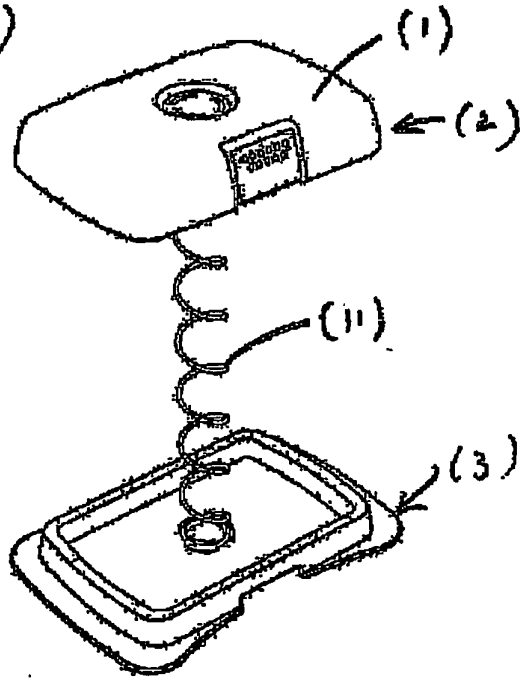
FIGURE 3(a)



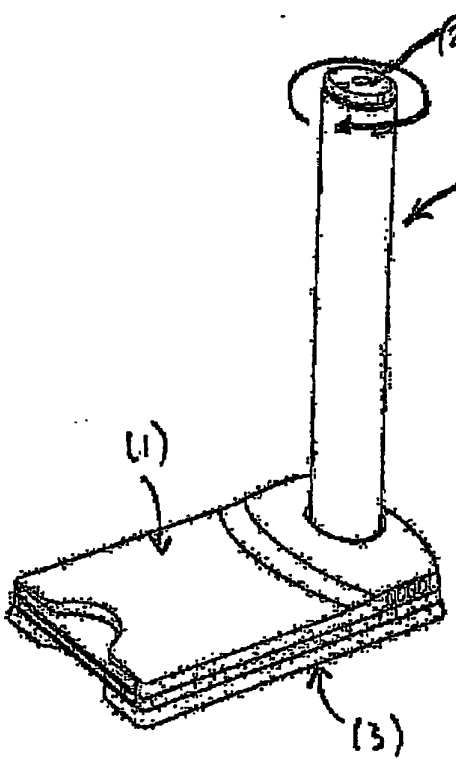
spring_open

FIGURE 3(b)

FIGURE 3(c)

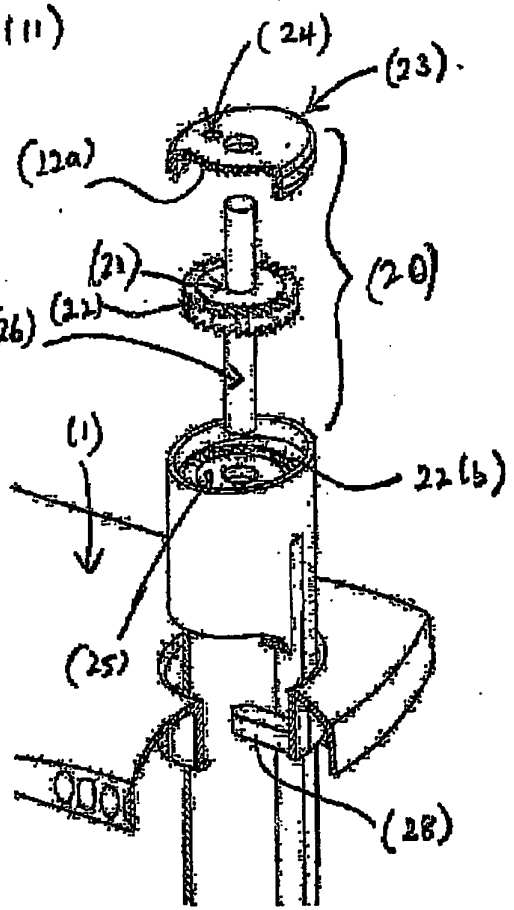


spring_open_no_paper



tower_closed

FIGURE 4(a)

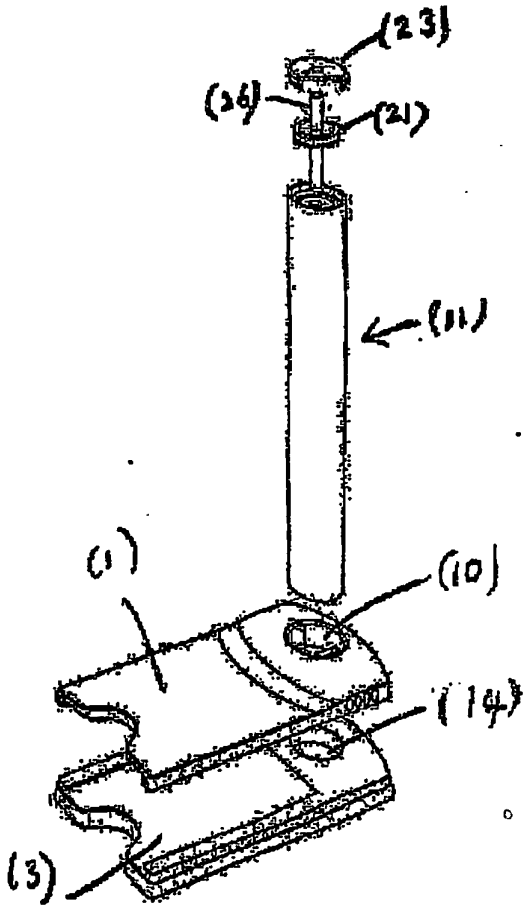


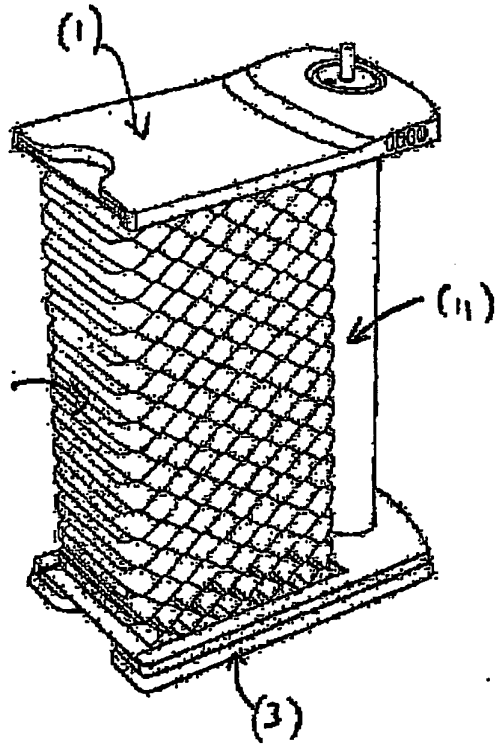
tower_cutaway

FIGURE 4(b)

FIGURE 4(c)

tower_exploded_A

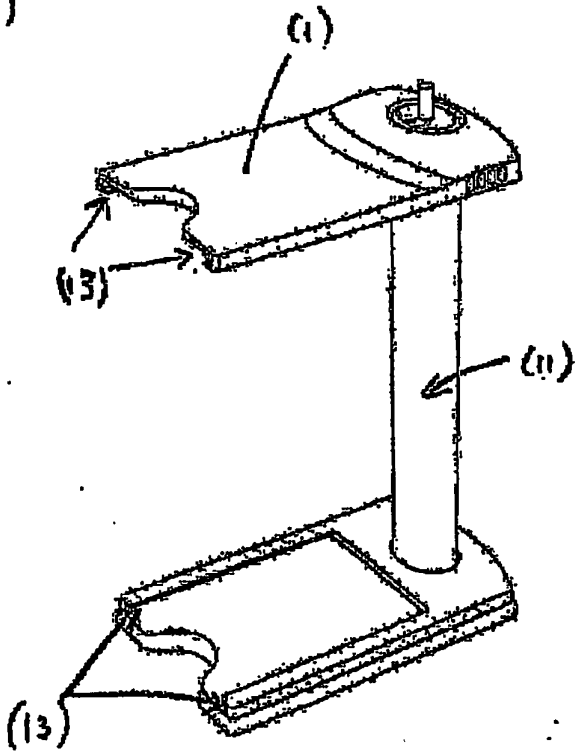




tower_open

FIGURE 4(d)

FIGURE 4(e)



tower_open_no_paper

tower_paper_insertion

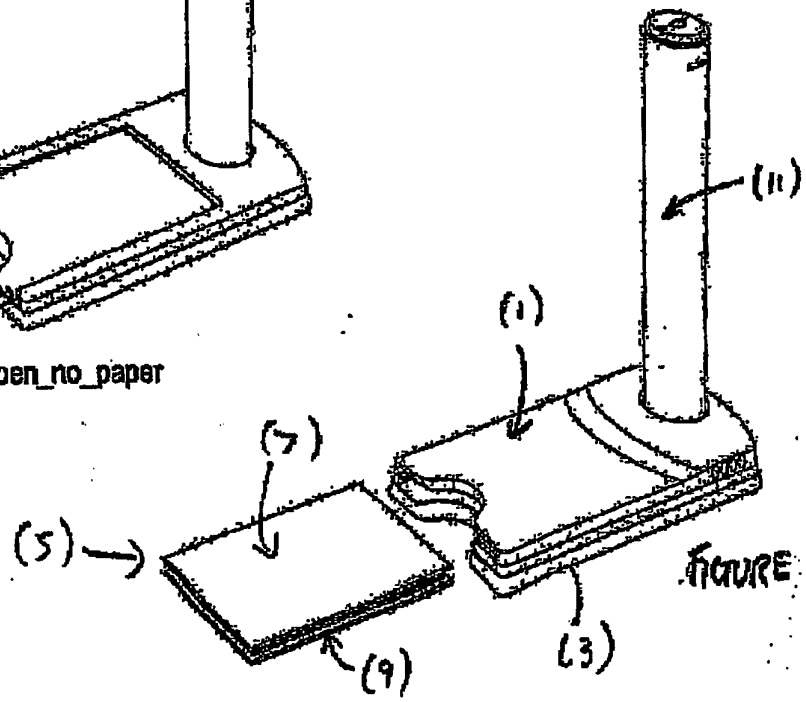


FIGURE 4(f)

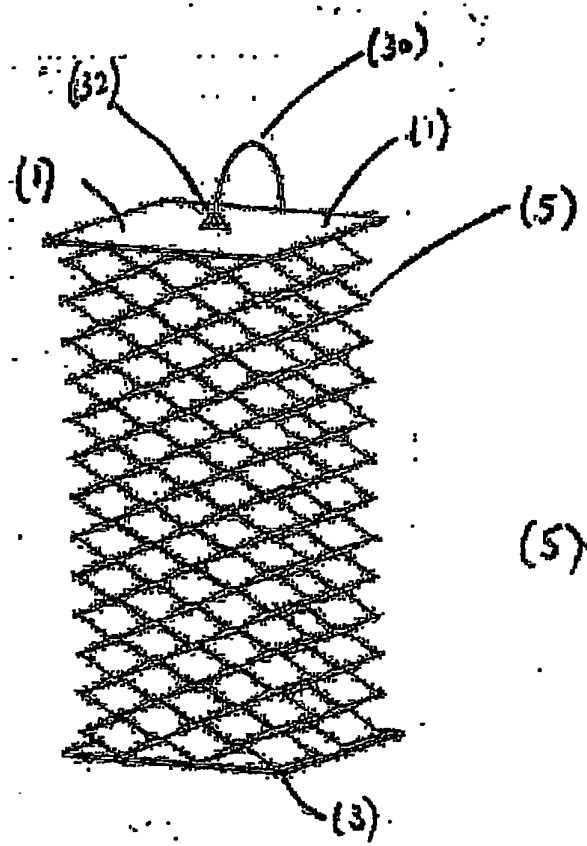


FIGURE 5(a)

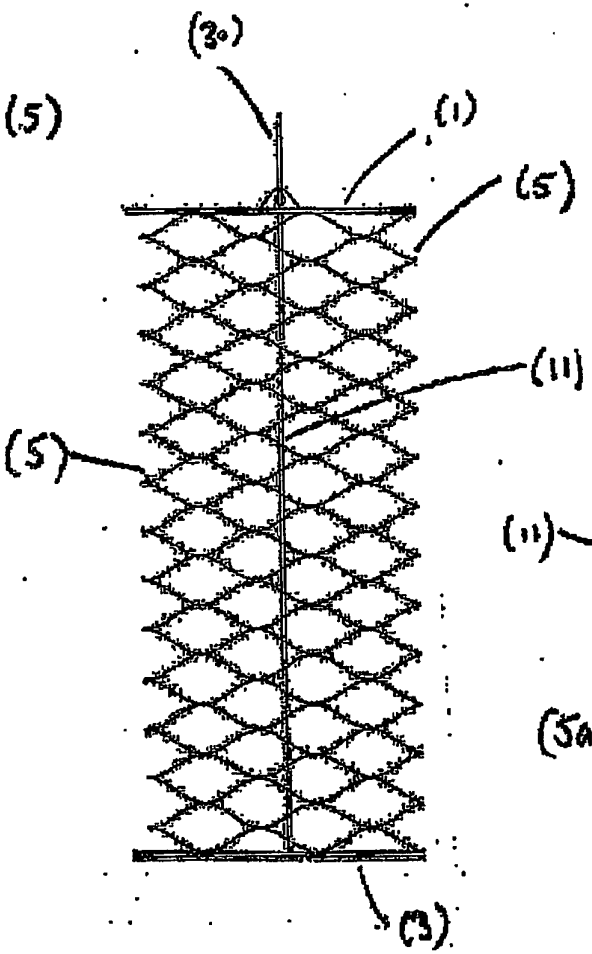
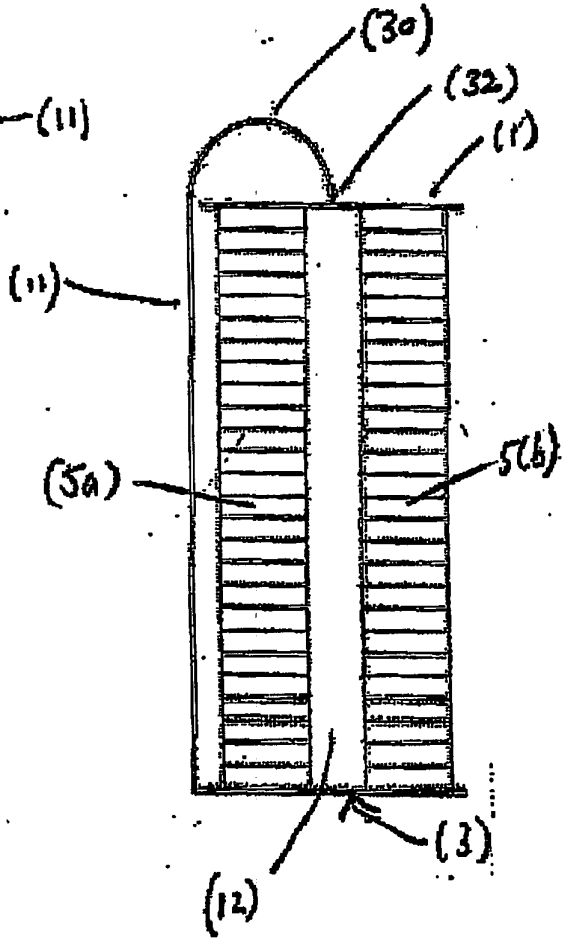


FIGURE 5(b)

FIGURE 5(c)



6/8

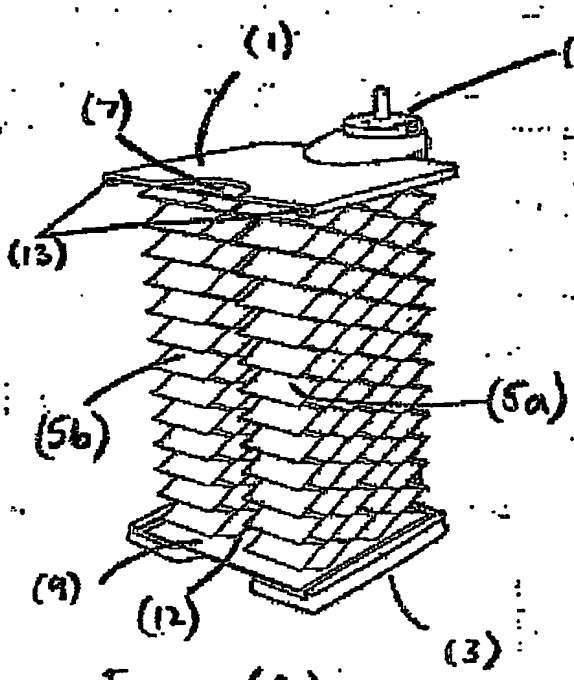


FIGURE 6(a)

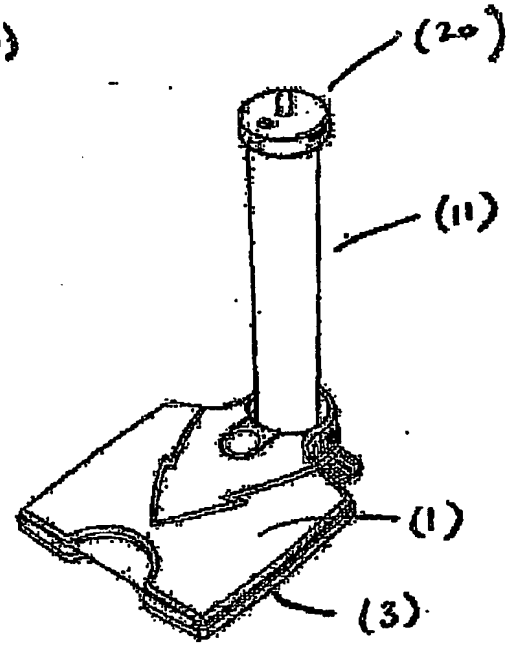


FIGURE 6(b)

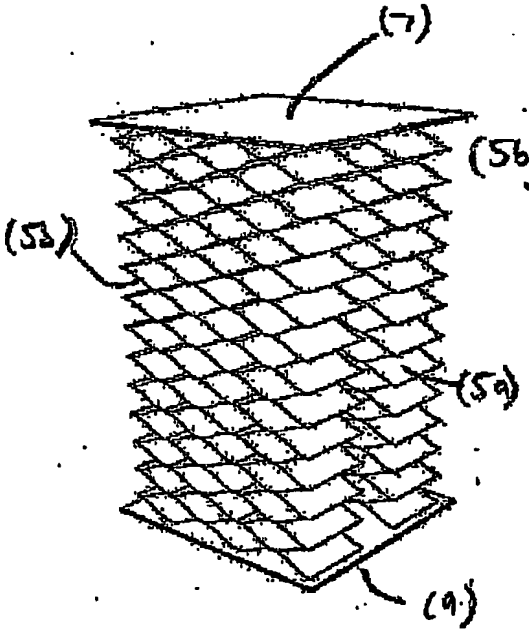


FIGURE 6(c)

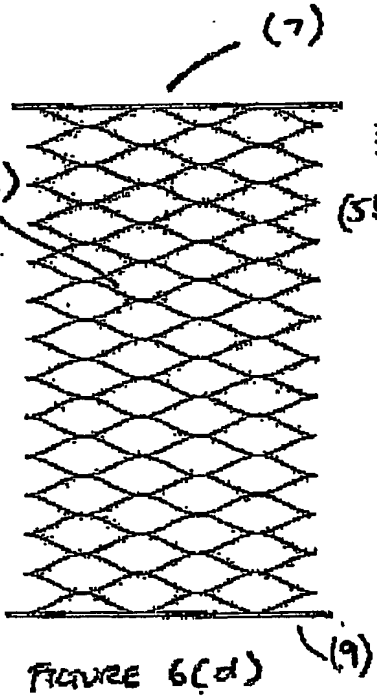


FIGURE 6(d)

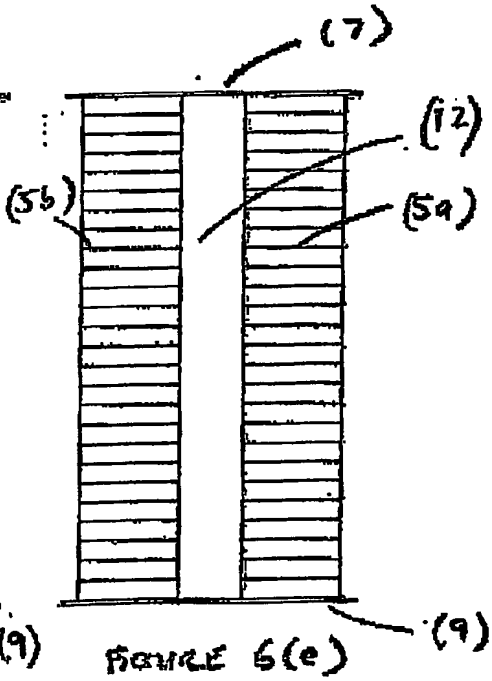


FIGURE 6(e)

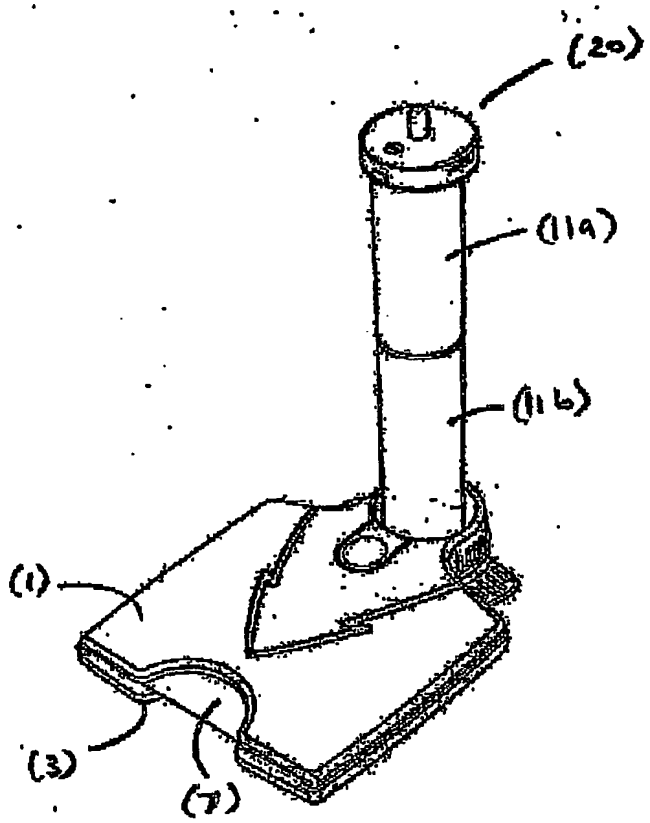


FIGURE 7

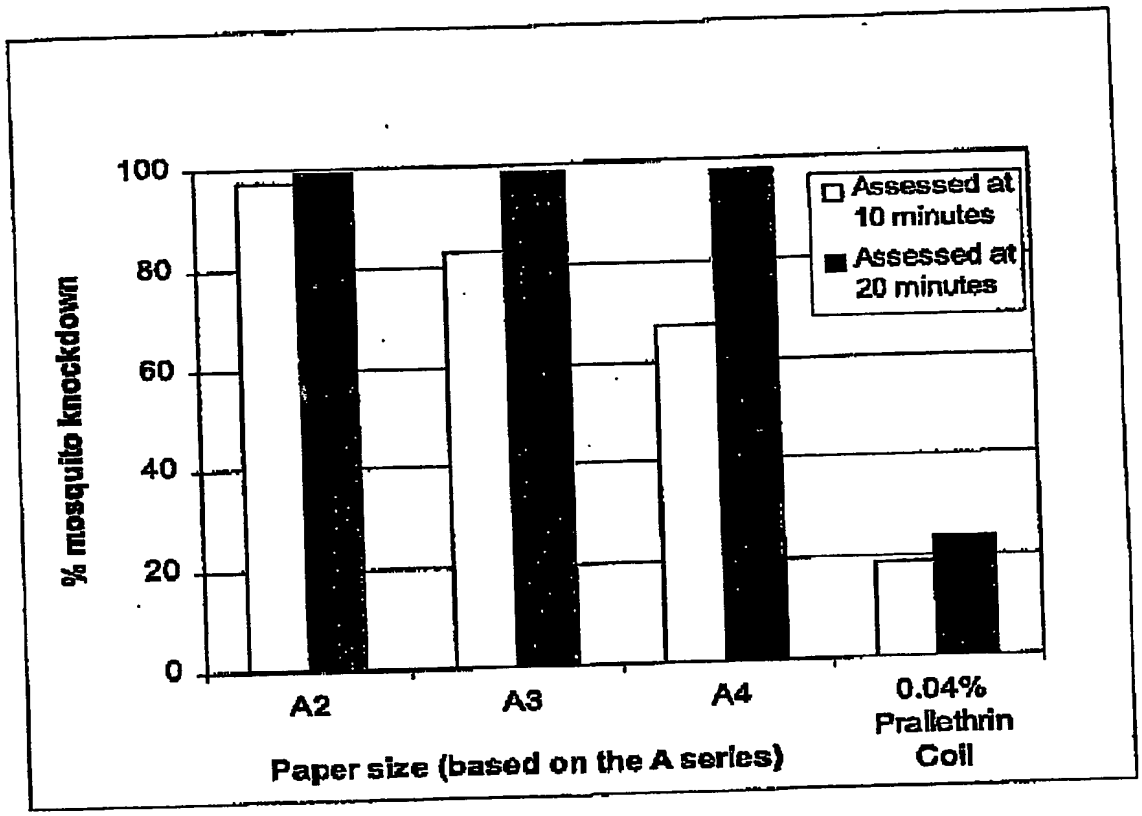

% mosquito knockdown
100
80
60
40
20
0
A2
A3
A4
0.04% Prallethrin Coil
Paper size (based on the A series)
Assessed at 10 minutes
Assessed at 20 minutes

Figure 1

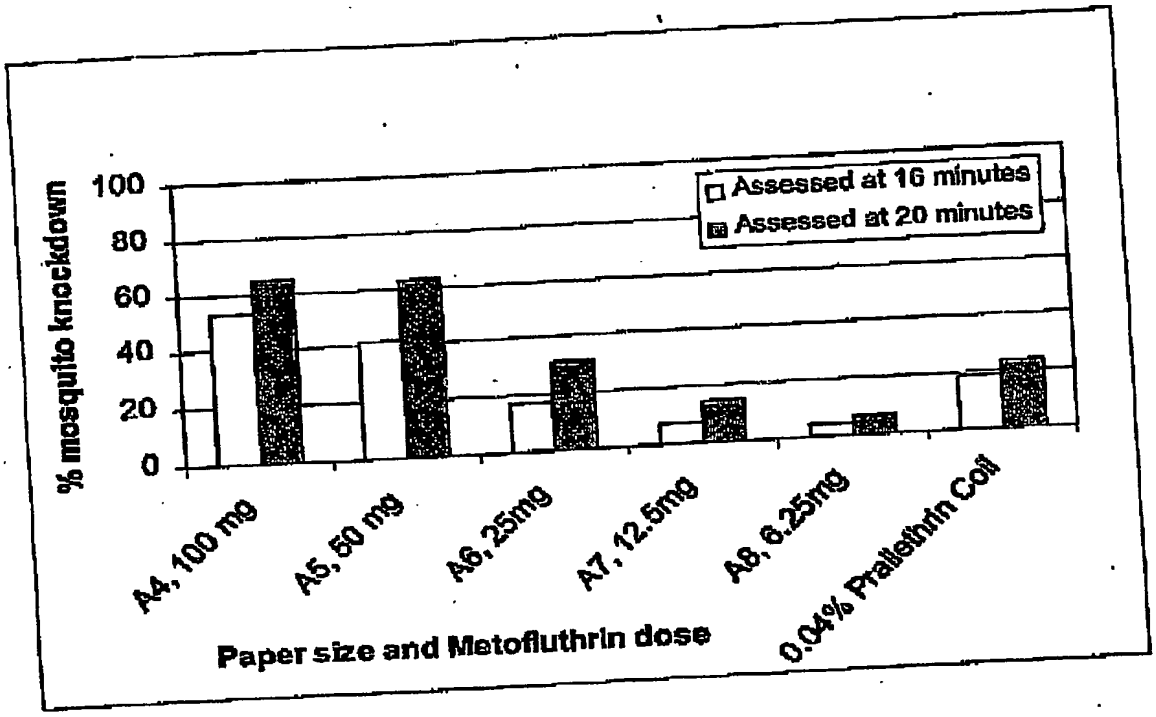

% mosquito knockdown
100
80
60
40
20
0
Assessed at 16 minutes
Assessed at 20 minutes
A4, 100 mg
A5, 50 mg
A6, 25mg
A7, 12.5mg
A8, 6.25mg
0.04% Prallethrin Coil
Paper size and Metofluthrin dose

Figure 2

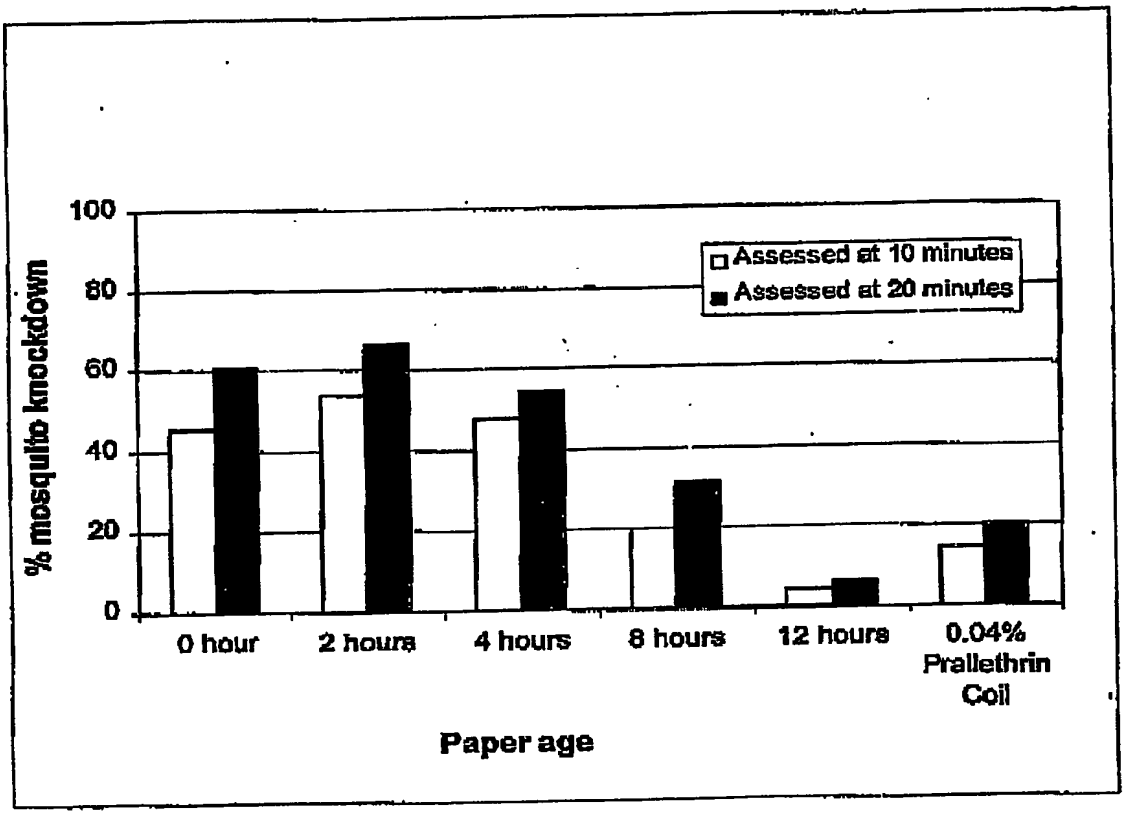

100
80
60
40
20
0
% mosquito knockdown
Assessed at 10 minutes
Assessed at 20 minutes
0 hour
2 hours
4 hours
8 hours
12 hours
0.04% Prallethrin Coil
Paper age

Figure 3

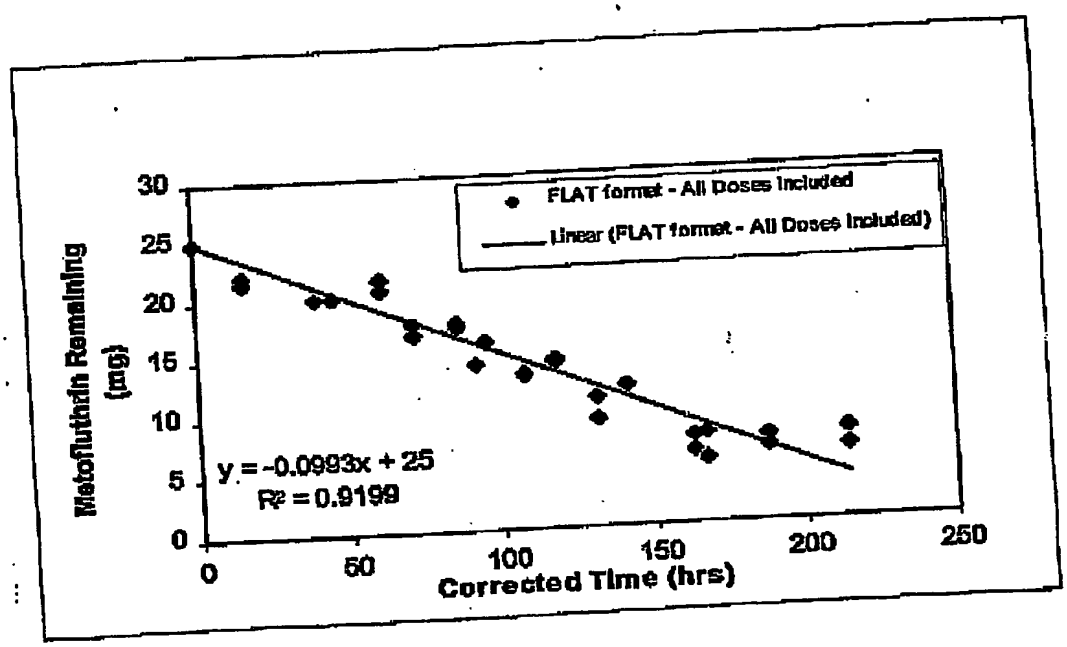

FLAT format - All Doses Included
Linear (FLAT format - All Doses Included)
Metofluthrin Remaining (mg)
y = -0.0993x + 25
R² = 0.9199
Corrected Time (hrs)
0
5
10
15
20
25
30
0
50
100
150
200
250

Figure 4

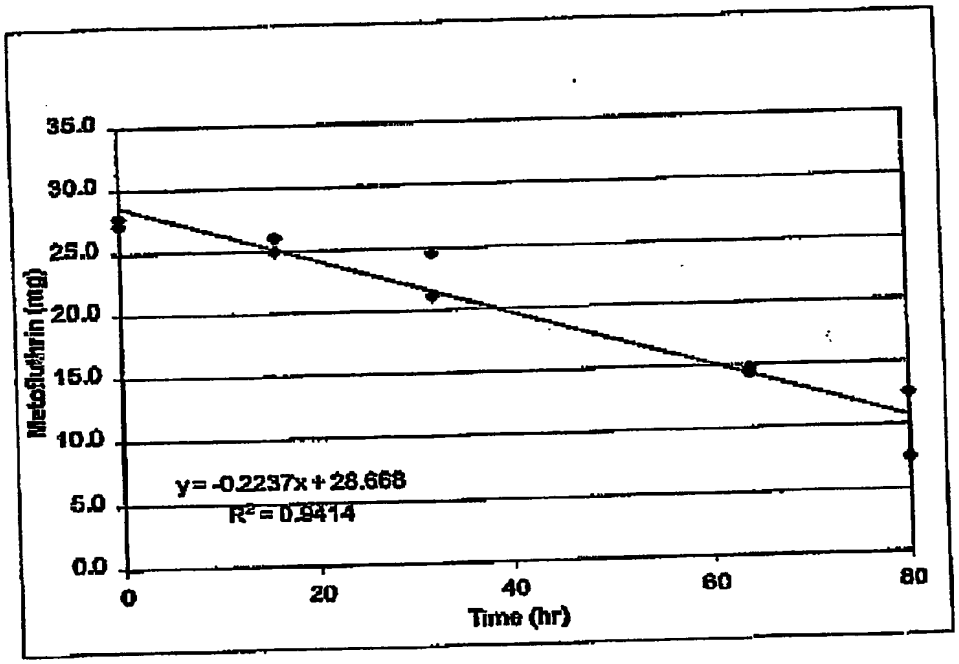

35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Metoflutrin (mg)
y = -0.2237x + 28.668
R² = 0.9414
0
20
40
60
80
Time (hr)

Figure 5

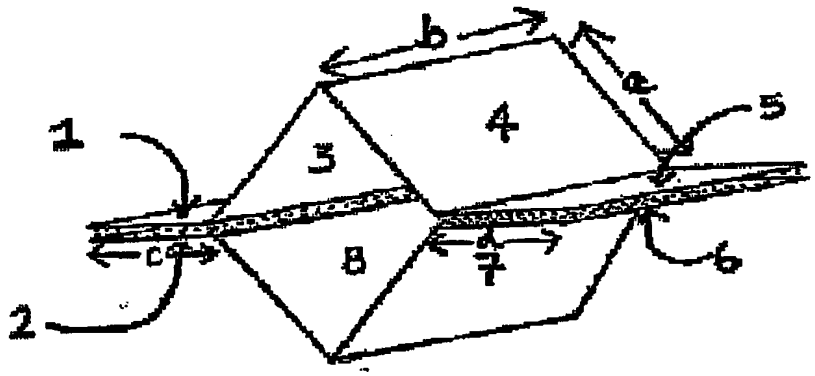


Figure 6